Linking Cognition to Cognitive Dissonance through Scientific Discrepant Events

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Abstract

The aim of this workshop and paper is to provide a conceptual framework that will develop skills in the areas of observation, cognition/meta-cognition with emphasis on critical thinking, decision making and problem solving. Simultaneously, this endeavour is designed to stimulate one's curiosity and thereby provide motivation to learn. These are accomplished through the learning style methodology with emphasis on interactive instructional resources addressing a multi-modality approach to teaching and learning. It will be shown that discrepant events impact thinking with respect to problem solving. The aforementioned is demonstrated with the use of gravity, molecular structure and optical illusions. The workshop presenters will show how cognitive dissonance, precipitated within each of these constituents, fosters curiosity and therefore provides an ideal motivational component for exploration.

Background and approach

The activities in the workshop are designed to highlight the above processes while engaging the participants in academic and social cognition through discussion and role-played experimentation. Additionally, using Vygotsky's [29] zone of proximal development (1978) and his views on children's intellectual growth, the authors believe one can address and examine the influence of cultural experiences which impact what one is thinking, as well as learning style preferences.

The CASE Project: Cognitive Acceleration through Science Education by Adey & Shayer, [3] (1994), Shayer [28] (1999), examined "how" people learn. This workshop addresses that while utilising a paradigm on a Reciprocal Thinking Chart (Schiering © 1999 [23], Schiering, Buli-Holmberg and Bogner, 2007 [27), which was originally based on the combined/synthesised works of Abedi and O'Neil [1] (1996), Abbott [2] (1997), Fogrty and McTighe [13] (1993), Deonarine [9] (1998), as well as Glatthorn [16] (1995). The paradigm, in Chart form, provides the participants with a viable means for knowing about academic and social cognition by realizing what one is thinking. It also takes into account their respective cultural and personal impressions addressing "how" one learns.

In conclusion, using the Reciprocal Thinking Chart in relation to the discrepant events, the participants will be observing, conducting and recording, through graphic design, their thoughts, ideas, opinions, and judgments concerning what cognitive skills they believe were employed during the workshop. Subsequently, data will be collected with respect to "what" one was thinking. A Chart is provided at the end of this paper which illustrates the data collection technique to be employed. In this workshop this Chart is implemented for future demonstration of the results of the in-workshop responses to cognitive and meta-cognitive functions of the individuals addressing the discrepant events. Furthermore, a qualitative questionnaire along with the aforementioned will be employed for observation, comparison and contrast to other such Charts. The individual's responses to their thoughts and feelings regarding the use of thinking reciprocity and emotional components as it pertains to successful learning will be analyzed.

Introduction

The authors believe that the educational process crosses an indiscriminate and interdisciplinary continuum that forms connections while correlating diverse populations and learning preferences. These are activated through learning style perceptual preferences involving auditory, visual tactual, and kinesthetic modalities. Conceptualizing the cogent attention to instructional methods that facilitate the student-learners cognitive and meta-cognitive skills and process, the authors examine the influence of scientific discrepant events on the individual's processes of comparing and contrasting, prioritizing, decision-making, problem solving, evaluating, , reflecting, analyzing, recalling, inventing, and self actualizing. This is accomplished through experiences with varied science experiments and demonstrations that stimulate cognitive dissonance.

Defining and Creating Memories

The question of why one remembers is given attention for comprehension of the importance of recalling and reflecting on past situations that may lead to decision making and problem-solving. What causes one to

remember some things and not others? Is this due to the style-of-delivery and the listener's interest in the content material? Is it due to the emotion that is associated with the memory? Does one of these take precedence over the other? First, it seems important to know about memory, which is the ability of the brain to reflect on and recall past experiences. Gazzaniga [14] (1998;10) stated, "Evolutionary theory has generated the notion that we are a collection of adaptations – brain devices that allow us to do specific things…Many systems throughout the brain contribute to a single cognitive function." Then, understanding how the memory works imposes a major dynamic when referencing the connections of hearing and seeing a specific science discrepant event and thinking about how this was possible and plausible when it seemingly defies inductive or deductive reasoning. "The most fundamental things scientists have learned about memory is that we do not store memories whole and therefore do not retrieve them that way either. When we remember something, we actually reconstruct it by combining the elements of the original experience" (Brandt [6] 1999:238) Neuroscientist Antonio Demasio [8], explains that a memory "is recalled in the form of images at many brain sites rather than at a single site (1994: 84).

The use of one's memory then applies to the ability to comprehend in three formats which include: 1). attention; one's ability to focus on a specific stimulus without being distracted**;** 2). Orientation; the ability to be aware of self and certain realities and facts of the present, and 3). Problem-solving: the ability to understand a problem, generate solutions and evaluate the generated solutions (HHH and Schiering, [17] 2004).

Culture, Learning, Knowledge, Cognition and Meta-cognition

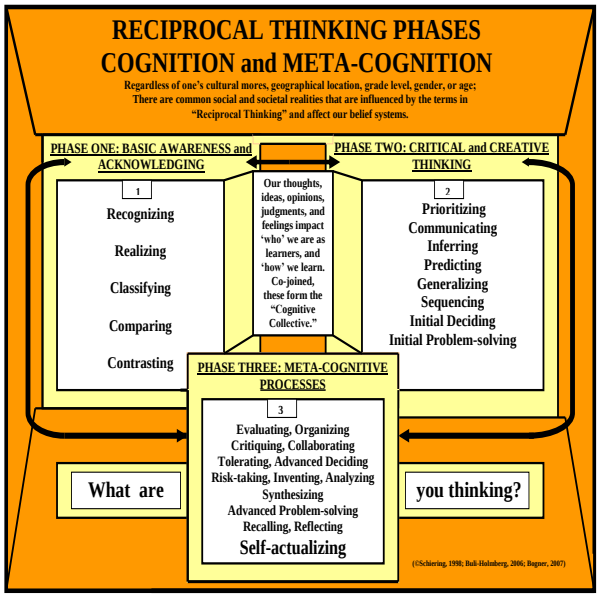
With respect to examining the influence of cultural experiences on one's thinking it is necessary to first address the term "culture." In the anthropological sense, a culture is a shared way of living and this collective provides recognition of differences and commonalities. "So, culture is also a medium for mental growth in that we learn and gain knowledge, reciprocally, sequentially, and simultaneously. We develop mentally through our common social and societal realities, which we encounter in the nuclear family and then extended family, school, community, and world" (Schiering, [25] 2003). Utilizing this information regarding learning, (Blank [5] 1997) reported that this leads to "knowledge acquisition," which is constructed when individual's restructure or replace existing conceptions. Students revealing and reflecting upon the status of their conceptions, how they know what they know, is the demonstration of comprehending what they've learned. This includes, "generalizations, facts, terms, dates, and names" (Glatthorn [16] 1995). Science experimentation [19], 2002) causes those involved to think, have ideas, form opinions and make judgments through "thinking" that corresponds to what is being related. "The reaction or thought-process-reciprocity, resulting from "doing" then serves as the foundational component that subsequently fosters learning, which leads to knowledge" (Schiering, {23},1999, Schiering, Bogner, Buli-Holmberg, {27},{2007)

According to Allport{4} (1937), knowledge is "a receptive, meaning making and active orientation" as it is "linked to cognition and then meta-cognition" (Bruer, {7}1993). Ennis {11}(1985) stated that one must consider generative knowledge, which is awareness of material to solve problems, while Pennell {18} (1985) noted that students who become aware that they have learning-style preferences might enable themselves to control their instructional conditions and take the first steps toward self-actuating in the meta-cognitive process. Learning style, learning, and knowledge are then linked to the concept of "brain lateralization and cognitive-style theory" (Dunn and Dunn, {10} 1992). Subsequently, the authors of this paper and workshop believe that it makes sense to teach students using their perceptual preferences and/or all four (auditory, visual, tactual, and kinesthetic) modalities.

Review of the Literature: Reciprocal Thinking

Referencing discussions between Schiering, Bogner and Buli-Holmberg [27] (2007) state, "One comes to realize that the words thinking and cognition are synonymous. Also, cognition, in the finite sense, refers to the ability of the brain to process, store, retrieve and manipulate information. Drawing on the work of Giroux's [15] concept of "Teachers being transformative intellectuals who practice a pedagogy in which both teachers and students become agents committed to the study of daily life," and Freire and Macedo's [12] (1995) concept of critical pedagogical approaches helping students construct an engaging knowledge based on their realities that help them to use their own background experiences as a self-empowerment tool, Schiering [23 & 24] (1999) with Schiering, Bogner and Buli-Holmberg [27] (2007), configured a Chart presently titled, Reciprocal Thinking Phases: Cognition and Meta-Cognition. The basic concept of this Chart was that of thoughts having structure whereby teachers and learners may address and identify the process of their thoughts for comprehension in literal (factual), applied (transferring the material to one's personal situation), and implied (inference as a result of indirect evidence) in the following formats: Beginning Awareness and Acknowledging, Critical and Creative Thinking, and The Meta-cognitive Processes. The Chart appears on the next page with an explanation following it respective of developing the aforementioned thinking skills.

Table 1: Reciprocal Thinking Phases: Cognition and Meta-cognition Chart



Explanation of Reciprocal Thinking Chart

"The first Phase represented on the Chart involves the utilization of skills for fact finding and ordering techniques that facilitate learners making connections to personal experiences, through the use of varied perceptual preferences/ modalities. Individual's are able to respond to stimuli to answer literal comprehension questions with accuracy while employing basic reasoning. "First impressions" are realized for further examination that's incorporated in Phase Two.

This second Phase addresses critical thinking in that learners process skills resulting from previous experiences and awareness. Determining outcomes from actions taken (interactive learning) provides a comprehensive set of applied and implied comprehension with thoughts for initial deciding and problem-solving, which is further addressed in Phase Three.

The Meta-cognitive Processes of Phase Three occurs when thinking goes beyond the cognitive and the learner actually knows what he/she wants to realize – exhibiting a control over his/her intake of material. There is critiquing accompanied by self-actualization with evaluation and synoptic exercises (general and summative overviews) occurring. As defined by Abedi and O'Neil [1] (1996) this refers to utilization of strategies for planning, monitoring, or self-checking cognitive/affective techniques, and self-awareness.

The reciprocity of the Phases calls for understanding that one does not move progressively from one Phase to another, but utilizes thinking skills from each Phase when a situation is presented for examination. Identification of what one is thinking serves as the culminating skill resulting from reflection and self-accounting, as well as self-actuating" (Schiering, Buli-Holmberg, Bogner, [27], 2007).

Science Discrepant Events, Memory and Thinking

Rauch [19] (2002) describes a discrepant event as one that appears to be illogical, but in fact is quite logical, and follows the laws of nature. With that definition in mind, the authors relate that a person observing a discrepant event, will establish a "memory" of it; that will be recalled by recombining the elements of that event. Rauch [20] (2002) states that when one first is observing a scientific discrepant event and later involving oneself in the experimentation process that there's a subliminal or intuitive understanding of what has happened. Rauch and Schiering [21] (2007) concur that demonstrating discrepant events has an impact on thinking and ultimately creates memory. This may be influenced through delivery style and provides for immediate and later reflection, for *within* lesson comprehension. Rauch and Schiering [22] (2008) substantiate their concepts of memory acquisition by using the science experiment as either a motivation or part of a lesson for cognitive and meta-cognitive skill recognition. This is accomplished by being aware of what one is thinking and self-actuating; meta-cognition. Subsequently, partaking in the science discrepant event experiment, requires interactive use of one's modalities/ learning style perceptual preferences (auditory, visual, tactile, kinesthetic), and becomes part of the individual's immediate experiential past, upon which he/she may draw for future decision making and problem solving. Hence, the meta-cognitive processes are twice addressed and memory of them substantiated.

Implementing Discrepant Events and Reciprocal Thinking

Rauch [20] (2002), partially used science discrepant events and optical illusions in two Molloy College science courses titled, *Science Curriculum and Methods for Diverse Learners* and *Advanced Science Content and Methodology for Diverse Learners*. The topic was introduced with first presenting a clothespin and asking the students to make predictions as to what would happen if the clothespin were placed on his index finger. The collective response was that it would "fall to the floor." And that is exactly what occurred. Next, Rauch produced a clothespin with one stem missing. He balanced this on his index finger and placed a man's belt across it. Audible gasps were heard as the placing of it across this finger resulted in the belt balancing perfectly. Following this modeling of a scientific discrepant event the class was compelled to ask "why" the belt balanced. Before

providing the answer, Rauch, calls on the students to think about what he/she observed and investigate different possibilities for what looked like an unnatural phenomena. Discussion proliferated the classroom as the conversations turned to evaluating the steps first shown and comparing them to the second set of circumstances. Clearly, there are resultant differing thoughts, ideas, opinions, and judgments which are conversationally-applied to individual's experiential past for a realization of common social realities through social literacy. Then, there comes to be comprehension of possibilities for the belt balancing on the spoke of a clothespin that is balancing on the tip of the professor's index finger. Numerous cognitive and meta-cognitive processes have been in-play with critical and creative thinking being at the forefront and self-efficacy being a byproduct for student-learner empowerment through knowing what he/she is thinking. This is followed by continued hypothesizing, with logical and implied comprehension. Finally, it's explained that the reason for the belt balancing is accomplished through a twisting motion called torque. Each student is then given a belt and single-spoke clothespin to practice what has been modeled. This is done prior to the modeling of another discrepant event. Using the Reciprocal Thinking Phases Chart, the students then examine their thinking. The use of the Identification of Reciprocal Thinking Terms Chart (Schiering, [26] 2004) is then utilized verbally and illustrated below for an examination of what individuals were thinking when the discrepant event was demonstrated and self-practiced.

Table 2: Reciprocal Thinking Term-Identification Chart (Schiering, 2004)

Phase One: Basic Awareness & Acknowledging	**Identification of Term Application: What's the Thinking?**
Recognizing	The science discrepant event
Realizing	The experience seemed illogical
Classifying	Balancing possibilities
Comparing	The two experiment formats and components
Contrasting	The use of one's finger and then clothespin for balancing the man's belt
Phase Two: Critical and Creative Thinking	**Identification of Term Application: What's the Thinking?**
Prioritizing	Favourite science discrepant event
Communicating	Discussing and investigating the possibilities for the belt –on-clothespin balancing
Inferring	One of the experiments wouldn't work
Predicting	The belt-on-finger would fall to the floor
Generalizing	Discrepant events seem illogical
Sequencing	The steps of the experiment
Initial-deciding	The belt-on-clothespin wouldn't work
Initial Problem-solving	Application of laws-of-nature
Phase Three: The Meta-cognitive Processes	**Identification of Term Application: What's the Thinking?**
Evaluating	The discrepant event experiments
Critiquing	Responses offered as explanations for why the belt did and didn't balance
Collaborating	On thoughts, ideas, and opinions
Tolerating	Some of the reasons given for the belt-balancing
Advanced Deciding & Problem-solving	Reaching the conclusion through inductive and deductive reasoning with applied comprehension
Organizing	The steps to be taken for balancing the man's belt
Synthesizing	The events of the experiments
Risk-taking	Giving answers in-class
Inventing	Hypotheses
Analyzing	One's thought processes
Recalling	Other science discrepant event experiments
Reflecting	On one's memory acquisition to solve a problem
Self-actuating	Conducting several discrepant event experiments in-class, along with optical illusions and explaining these events. Designing one's own experiments.

Conclusion

In conclusion ,one's ability to increase the efficiency of one's learning, retaining knowledge and applying it, can be enhanced when one is aware of what one thinks, how one prioritizes and makes decisions. The use of this self knowledge is not unlike the professional athlete, who, knowing his/her strengths and weaknesses can respond in a variety of sports related settings by adjusting his/her approach or tactic to maximize the chances of achieving his/her goal. Indeed, time spent on self actuating, is time well spent.

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