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A Literature Review of the 3CAM Model: A Pathway to Apply Critical Thinking and Mastery in a Classroom

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Abstract

This review of the literature starts with the theoretical framework and culminates in a picture of the 3CAM model. The literature review focuses upon the relevant literature for each of the components of the 3CAM model: mastery learning, concept maps, critical thinking, collaboration and assessment. The literature review will come to an end with a review of the 3CAM model.
Keywords: mastery learning, concept maps, critical thinking, collaboration, assessment

Introduction

Theoretical framework

The theoretical framework is a new perspective on a theory of critical thinking that will enable students to learn and achieve at a level of mastery. In the past mastery learning has been predicated on students having sufficient time and resources to reach high levels of achievement. This approach assumes that students need the appropriate skills to achieve at a high level.

The language games of critical thinking (LGCT) is the theoretical orientation in understanding thinking. This theory (LGCT) is a skill-based approach to teaching the language games of critical thinking. The theory is derived from Bloom's (1974) theory of mastery learning, Chomsky's (1959) theory of language and syntax, Wittgenstein's (1954) concept of the language game and Gordon's (2018) conception of the role of assessment in education. These

theories are blended together to create the language games of critical (LGCT) to create a theory of the language games with syntax.

The language game of critical thinking is the theoretical perspective that is the basis of the 3CAM model. The LGCT proposes that the critical thinking questions of "what, how, when, where, what, and who" are constitute a language. The LGCT is like all languages, children learn to speak the language in a natural and effortless way during the normal course of everyday life. Like all languages, the LGCT has a syntax, semantics, and pragmatics. The critical thinking questions are not new, and were first described by Aristotle and they are to be found today in the daily work of detectives, scientists, and ordinary citizens.

The work of Chomsky, Wittgenstein, Bloom, and Gordon provide a theory of a language of thinking created to close the achievement gap in classrooms. Every language needs a context for learning and development, and Bloom's concept of mastery learning is the theoretical context for the language of thinking. Bloom's context is a classroom in which all children are capable of achieving mastery through learning the language of thinking. His taxonomy of higher order thinking are the basic elements or components of the language of thinking. Chomsky's key revelation is that a language must have a grammar and a syntax that provides the dynamic process to the language of thinking. The late Wittgenstein' theory of the language game integrates the different components of the language of thinking. His view is that the language of ordinary people is perfectly in order, and the language games of thinking consists of a series of activities called a language game. Gordon (2018) insight that in the past education has directed the science of evaluation but in the future, the science of assessment will give direction to education, triggered a reimagining of the purposes and tools of assessment.

BLOOM

Benjamin Bloom's Taxonomy of Higher Order Thinking is an important contribution to the 3CAM model. His Taxonomy is a framework for creating and designing learning objectives and assessment processes. The taxonomy is an observable set of mental processes that are key to success in schools. It is arranged in a hierarchical fashion of increasingly complex cognitive functions that include: knowing, comprehending, applying, analyzing, synthesizing and evaluating. Over the decades teachers have found the taxonomy to be a useful guide in lesson planning as they set about creating objectives for instruction. Researchers also rely upon the Taxonomy as the standard for ordering and researching the element of higher order thinking. The Taxonomy originated from Bloom's work as University Examiner at the University of Chicago (Bretucio, 2017). The University Examiner was a legacy of the British University system, and tasked with the responsibility of designing, implementing and scoring term examinations. Bloom and colleagues from the American Psychological Association worried about the lack of clarity and consensus in the construction of tests. They created a system of evaluation that would constitute a common language for the field of educational assessment. Their intentions went beyond the cognitive realm to include emotional and psychomotor competencies. Despite their cautions to the field, the taxonomy of higher order thinking became the defacto standard for teachers as they went about the development of lesson plans and curriculum.

Bloom's contribution to the 3CAM model is a vision of mastery learning and a taxonomy for measuring it. Mastery learning is thus defined as the gathering of facts, comprehending, applying, synthesizing, analyzing, and evaluating knowledge. As this explanation of the 3CAM model unfolds it will be clear he has provided a goal worthy of education, mastery learning, and he has provided a metric to gauge progress toward that goal. Missing so far is a vehicle for

reaching the goal, a candidate for the missing link is the 3CAM model of mastery learning based the language games of thinking.

CHOMSKY

Chomsky (1959) review of Skinner's book, Verbal Behavior (1957), set in opposition two competing accounts of language acquisition. The first has been characterized as experiential and the second as biological or formalistic. Skinner (1957) was a landmark experiential account of language acquisition using behavioral principles. Chomsky's Aspects of Syntax, was a biological and formalistic account of language acquisition. A half century and more later, the dichotomy between the two positions has blurred and it is increasingly recognized that the competing accounts of experience and syntax are not mutually exclusive but are essential aspects of first language acquisition. The same arguments and debates are present in second or bilingual language acquisition. This perennial debate is important because the same issues are present in a consideration of second language learning, and the language of thinking.

The characteristics of a language include: 1) from a finite set of components, an infinite set of possibilities, 2) recursion is defined as in terms of itself and its types. The types fold into themselves in an endless, repetitive and cumulative process, 3) a minimal stimulus elicits maximum possibilities, 4) everyone learns to speak the language by four years of age.

The merge function is the essential element in Chomsky's work that contributes to the model. It accounts for the merging of words while in the 3CAM model, the merge function provides a way of merging and ordering the components of the activities of the language game.

Prior to Chomsky, experiential accounts using behaviorism and reinforcement theory were widely accepted as the standard tools to understand the development of language. After his

review, Chomsky's theory of universal grammar became the major influence upon the study of linguistics and language development. There is still debate among linguists and psychologists as to the origins of syntax. Chomsky still argues that syntax is an evolutionary adaptation of relatively recent origins. Others argue that syntax is simply a function of the massive computational learning by the human brain. The debate continues about the origins of syntax, and interestingly no one debates the centrality of syntax and grammar to the development and learning of languages.

WITTGENSTEIN

Ludwig Wittgenstein (1896-1954) one of the great philosophers of the twentieth century authored two texts: The Tractatus Philosophicus and the Philosophical Investigations. In the first he offered a picture theory of thinking and in the second he introduced the concept of the language game. These texts are thought by some philosophers to be diametrically opposed to each other. Wittgenstein thought the two views to be complementary. The first presented a picture theory of thinking in which pictures mirrored reality, and truth was defined as the correspondence between the picture and reality. Language in this system was a system of transferring pictures from one mind to another. In the Philosophical investigations he changed his mind, and introduced the concept of language as consisting of innumerable language games.

The language game was introduced to break the hold of dualism on the thinking of philosophers. Dualism is the idea there are two distinct worlds, the mental and the physical. His concept of the language game put the concept of dualism to rest because he showed the mental and the physical belonged to the same realm. Wittgenstein showed that language games have their origins in the activities of daily life, and the shared agreement of community rather than a priori mental conditions. Language games are created, persist, change, disappear, reappear,

interact and sometimes conflict with each other. Language games range from the simple such as: a greeting, a salute or a child's game such as ring around the rosie to the strings of language games found in theoretical physics. Following rules, using role models and beliefs are important in learning the language games of daily life.

The concept of the language game resembles John Dewey's concept of experience or the everyday tasks or activities in settings in which moral deliberations take place and character is formed. Within these local settings individuals debate and agree about how to live their lives. Experience has its own rhythm, boundaries, beliefs, rules, virtues and goals. Within experience the ego disappears within the whole, and the common good becomes preeminent. Concurrently, with experience a new sense of moral identity emerges.

Every culture sets standards for language games (skills and knowledge) for which its institutions are responsible. Every culture is composed of institutions or forms of life in which its members work in the spirit of the whole. At the foundation of institutions are beliefs and values that provide the criteria by which the language games are played. At each stage of development children must master certain skills and knowledge of the different institutions, and deviation is not acceptable.

There are public and private language games. Public language games are shared activities in public view while private language games go on in our heads as thinking skills. Wittgenstein shows that the language games begin as shared activities in open view, and later these same activities are practiced in silence. As an example, we learn to add with objects in our hands, a public language game before we learn to add in our heads a private language game. We learn to read out loud before we learn to read silently.

Wittgenstein contribution to the 3CAM model are two-fold: the emphasis upon a picture theory of language and the concept of the language game. The picture theory of language translates reality into pictures. A picture language preceded spoken language for millions of years and insured the survival of early men. Within the 3CAM model the correspondence between text and the concept map provides students with the means to create a new reality based upon their backgrounds of knowledge. The framework of the language game incorporates pictures in the language games of daily life. The second fold which is the language game includes both pictures and language. Wittgenstein was clear that the relationships between pictures and language permitted a focus on a particular aspect of a picture. Within the language game it was now possible to focus upon "aspects of the picture". Within the 3CAM model the combination of pictures and words becomes a powerful tool for understanding the concepts.

GORDON

The 3CAM approach is prompted by Edmund Gordon's (2017) view that the science of assessment has achieved considerable precision in understanding how to guide, classify hierarchically, predict, select, and certify based on developed abilities. At the same time, he noted that the science of assessment has neglected the use of tests to better enable learning as in diagnosis and possible treatment. 3CAM is a methodology designed to demonstrate that assessment can facilitate the learning of critical thinking and other higher order cognitive skills. Gordon argues that the science of assessment has reached the point where soon, assessment will provide new directions to educational practice. In the past education has given direction to assessment, in the future, this relationship will be turned on its head, and the science of assessment will give new directions to education.

Gordon's contribution to the 3CAM model is methodological in that his conception of dynamic assessment in Thomas and Gordon (2013) , provides a template and broader background against to consider the learning of the language game of thinking. Dynamic assessment is defined by Gordon as dynamic process in which assessment, instruction, curriculum and learning are inseparable. The language game is the theoretical perspective against which will be compared to dynamic assessment. This juxtaposition asks the question, how does assessment, learning, instruction, and learning map on to the language game?

In dynamic assessment instruction, learning, curriculum, and assessment flow into each other. The same dynamic relationship holds for the 3CAM model. If we substitute the language games of thinking for learning, the similarity between the models is clear. The study of learning has given way to the study of thinking. In the language games of thinking hypotheses, the data, and the conclusions flow into and are inseparable from each other. The application of critical thinking on concept maps, the concept-questions, and the reasoning questions flow into each other.

The language game of critical thinking is a theory of thinking that transforms the language game into a dynamic language in which the different components of the language game merge, fold into each other, and re-emerge in a continuing process of making sense of the world. Language games range in complexity from the simple to the complex while retaining the merge function. The components of the 3CAM model are components of a language game and they merge and fold into each other. Bloom's contribution of the Taxonomy of Higher Order Thinking is a template to classify the complexity of thinking. Gordon's contribution is to reimagine the assessment and the components of the language game as an opportunity to cultivate learning while transforming the teaching of critical thinking.

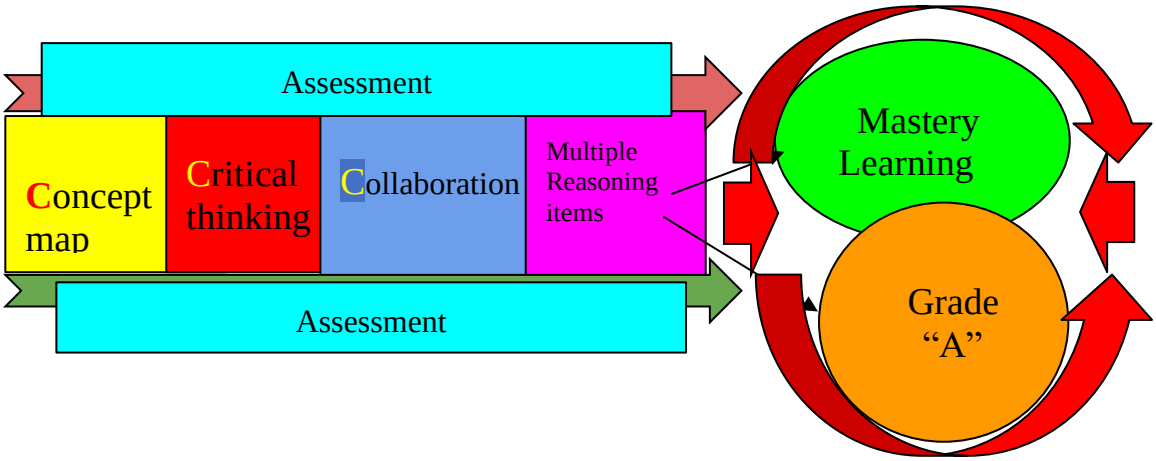

Figure 1: Components of 3CAM conceptual framework

Literature on each component of 3CAM model (mastery learning, concept map, critical thinking, collaboration and assessment)

Mastery Learning

Bloom's work on mastery learning contextualizes and reimagines a vision of schooling in which all children can be successful. The history of mastery learning begins with Thorndike (1959), Carroll (1963) and Bloom (1974), who proposed the concept of mastery learning as a way of closing the knowledge gap between high and low achieving students. These theorists were in agreement that given sufficient time and appropriate instruction all students could attain mastery of the content of instruction. The idea that all students could achieve mastery was and remains a radical idea. Bloom's model of mastery learning is a template for understanding past and current approaches to mastery learning (Gusky, 2007). Bloom was concerned with eliminating the achievement gaps between students differing in ethnicity, languages, economic and cultural backgrounds. He observed that many factors outside of school influence the academic achievement of students. He was convinced that teachers could have a significant

impact upon classroom. One of his more trenchant observations was that teachers displayed very little variation in their teaching practices, and as a consequence there were large variations in student achievement. Under these circumstances the pattern of student achievement approximates a normal distribution. To achieve better results and improve achievement, he recommended that teachers increase the variation in their teaching.

It was taken for granted in the 1950s, 1960s and 1970s that the gap in achievement between whites and people of color was due to hereditary factors. Anderson and Block (1977) defined mastery learning as a philosophy of school learning, an associated set of instructional practices, and the idea that mastery learning and education are embedded in values about students and learning.

In the 1980s this idea came under severe criticism from many critics. Slavin (1987), for example, argued that classroom data did not support the advocates of mastery. Kulik, Kulik and Banger-Drowns (1990) with wider review of the literature reached the conclusion there was merit and evidence for mastery learning. Interest languished for several decades and was recently brought forward again by Gusky (2007). The concept of mastery still captures the imagination of practitioners and theorists searching for equity in education.

Models of mastery learning have all but disappeared from the educational research literature. Two decades have passed since mastery learning was a topic with currency, and an active topic in the research literature. In contrast mastery learning is a hot topic in the fields of medicine and nursing with hundreds of articles being published over the last two decades. The untimely disappearance of mastery learning was not alone other child centered, developmental, socially and emotionally oriented programs have also disappeared. Their disappearance coincided with the ascendency of the cognitive accountability regimes of the No Child Left

Behind Law. Testing and multiple-choice testing in particular became the criteria by which educational progress is measured. Educational standards are set to ensure that all children achieve a certain level of proficiency. Models of mastery learning and other child centered programs were not able to meet the new accountability standards. The result is that schools, teachers, and educational policy makers have turned to teacher centered classrooms and highly structured curriculums to reach high levels of accountability and achievement.

Concept Maps: The Deconstruction of Text into Personal Knowledge

Concept maps are a node-link diagram in which each node represents a concept and a link that identifies the relationship between the two concepts (Schroeder, Nesbit, Anguiano and Adesope, 2017). In the process of creating a concept map, students deconstruct the text into their personal knowledge. As students deconstruct the text they make the knowledge within the text their own. Their thinking is now visible, and the concept map is a picture of their knowledge. This picture knowledge is personal because in the student's mind are the background knowledge and skills previously learned. Some of the background knowledge is tacit (Polyani,2009)

Concept maps originated at Cornell University in 1984 in the work of Bill Trochem and a doctoral student, Dorothy Torre (Donnelly, 2017). Concept maps are a form of visual or picture thinking. Picture thinking is fast, automatic, effortless, often unconscious, and brings images to mind, spreading neural activation, enabling the individual or group to respond more easily than before. Concept maps are examples of visual thinking. When we understand something, we say that we "see" it. We arrive at the solution to a problem through "insight." To better communicate our ideas, we aim to make them "clear." Such metaphors likening cognitive processes to visual

experiences are so pervasive as to suggest a close correspondence between how we think about and how we see the world (Fan, et al, 2015).

Concept maps are situated in the visual thinking tradition in which signs on maps represent knowledge in space. These maps are what Jonassen (2000) calls mind tools. Mind tools are cognitive amplification and reorganization tools which exceed the limitations of the human mind by doing things more accurately and at a higher speed, and extend the use of other mechanical tools. Mind tools are generalizable from one setting to another engaging and facilitating cognitive processing. They help learners think for themselves and make connections between concepts and create new knowledge. Here-to- fore, the workings of the mind have not been open to public view. The use of mental maps reveals to students, ourselves and others, the workings of the mind.

A meta-analysis of concept maps by Nesbit and Adesope (2017) is a theoretical and practical analysis of the existing experimental research and a guide to future research and inquiry. They succinctly begin with the observation that concept maps or knowledge maps are diagrams that represent ideas as node link-assemblies, and there has been a steady increase in the number of published studies over the past thirty years.

Their review of the literature starts with theoretical orientations that have driven research into concept maps. They begin with Paivio (1986) who outlines a dual processing theory, verbal and visuospatial, that encodes information into distinct verbal and visuospatial memory systems. Links between the two systems are pathways for the sharing of information. The two systems work together to enhance the processes of learning and the retention of memories. Learning from geographic maps is a useful analogy to the learning of concept maps. Geographic maps are much

more efficient ways of remembering lists of places and objects than providing lists of the same places and objects.

Drawing concept maps is one of the most basic of visualization techniques and an invaluable resource for understanding thinking. Drawing is the manual mark-making techniques which produce images that serves some purposes. Maps, graphs, sketches, diagrams, charts, outlines and so on are techniques that facilitate thinking. Drawing is a way of observing the inner and representing the outer world.

Concept maps are considered as a good tool to assist the instructor to organize knowledge and an appropriate tool for students to notice the important concepts in different materials (Novak,1991; Jonassen Beissner, & Yacoi,1993).

The learner's increasing confidence in the creation of concept maps is an important consequence of the use of concept maps. Students are often told it is important to improve their thinking or simply to start to think. The use of concept maps makes it possible to chart the improvement in the thinking of students. Many students have absorbed the criticisms that they do not know how to think. Concept maps make it possible to show students a picture of their thinking and how to improve their thinking.

Critical Thinking

This brief history of the critical thinking questions produced some surprises. The first surprise is that the 5 "Wh questions plus how" began as seven in number, invented by Aristotle, and he called them the Seven Circumstances. In his book, the Nichomachean Ethics, he describes what was required if a person was to live a virtuous life. He thought of the seven circumstances as a schema to determine if an act was virtuous. During the middle ages Cicero transformed the seven circumstances when they were moved from the ethical realm to the public realm of debate

and rhetoric. In modern times the five “Wh plus how questions” have become the favorites of journalists, philosophers, educators, and each embraced the view that the critical thinking questions were cognitive tools to share information.

Like many after him, Aristotle found it easier to list the seven circumstances than define them. He listed them as (1) the who, (2) the what, (3) the around what place or (4) in which time something happens, (5) with what, such an instrument, (6) for the sake of what, such as saving a life, and (7) the how, such as gently or violently.

The seven circumstances were a schema critical to Aristotle’s determination to show that an act is virtuous or shameful if it is completed. If one of the seven circumstances is not known, the act is not virtuous. Defining the differences between involuntary and voluntary actions was critical, and acts done in ignorance are not voluntary and bring about regret. He is not concerned with general ignorance but ignorance of particular circumstances.

According to Sloan (2010), Cicero based much of his work on Aristotle who wrote about the seven circumstances from the point of view of a philosopher while Cicero writes about the seven circumstances as a lawyer preparing a defense. The circumstances are a means for confirming an argument or adding authority to a speech. In everyday language, the circumstances are a template to make a narrative plausible. The seven types of circumstances now become a basic set of questions one ought to pursue to supply information and corroborate one’s claims. Sloan quotes Cicero, “All claims are confirmed by argumentation or is attributed to (1) person, (2) the action, (3) the place, (4) the time, (5) the mode, (6) the occasion, and (7) the means will be investigated.

In modern times journalists have adopted the 5 “wh questions” as a template for storytelling: who was involved? What happened? Where did it happen? When did it take place? and why did it happen? Some writers add how to the list. These questions are a template for getting a

complete story. If one of the questions is not answered, the story is not complete. Each question requires a factual answer, and none of the questions can be answered with a simple yes or no.

Lai (2018), a psychologist, in her review of the literature defined critical thinking as actions or thoughts that critical thinkers are able to do. Cognitive psychological focused on how people think in comparison to how they should think under ideal circumstances (Sternberg, 1986). Halpern (1998) defined critical thinking as "the use of those cognitive skills or strategies that increase the probability of a desirable outcome". This perspective includes a checklist of procedures conducted by critical thinkers (Lewis & Smith, 1993).

According to Willingham critical thinking is "seeing both sides of an issue, being open to new evidence that disconfirms your ideas, reasoning dispassionately, demanding that claims be backed by evidence, deducing and inferring conclusions from available facts, solving problems, and so forth" (Willingham, 2007, p. 8).

Educational researchers have emphasized the cognitive dimensions of critical thinking. Benjamin Bloom and his colleagues focus upon teaching and assessing higher-order thinking skills of analysis, synthesis, and evaluation in classrooms. Other educationally oriented researchers have focused upon a wide range of cognitive skills including hypotheses generating, analyzing, reasoning (Ennis, 1985; Facione, 1990; Halpern, 1998; Paul, 1992); reasoning applying inductive and deductive reasoning (Ennis, 1985; Facione, 1990; Paul, 1992; Willingham, 2007); assessing or judging (Case, 2005; Ennis, 1985; Facione, 1990; Lipman, 1988; Tindal & Nolet, 1995); and decision making (Ennis, 1985; Halpern, 1998; Willingham, 2007).

Among philosopher's questions and answers have taken a decidedly cognitive turn in the twentieth century when they study of language shifted to the study of declarative sentences and

propositions. At the same time, it was evident that questions and answers were of equal importance. The linkage between questions and declarative sentences became a subject of great interest though questions did not attain the level of importance afforded propositions and declarative sentences. Recently, a renewed emphasis upon the semantics and pragmatic dimensions of questions and answers marks a return to an emphasis upon the circumstances of human action**. (**Sullivan,2013; Manor, 1982, Hintikka & Halonen,1995; Korta & Perry,2006)

The role of collaboration in critical thinking

Deductive instruction, modeling, collaborative learning, and constructivist skills are different strategies proposed by different researchers to apply critical thinking. Most of the researchers are advocates of the role of explicit instruction in the improvement of critical thinking (Abrami et al., 2008; Case, 2005; Facione, 1990; Halpern, 1998; Paul, 1992).

Collaborative approach to teach critical thinking is highly recommended by different scholars (Abrami et al., 2008; Bonk & Smith, 1998; Heyman, 2008; Thayer-Bacon, 2000). The collaborative approach is consistent with Vygotsky's theory that highlights the value of social communication for developing cognitive skills (as summarized in Dillenbourg et al., 1996). Vygotsky proposed ZPD (zone of proximal development) as a gap between what a learner can achieve by herself and what she can achieve with the help of a more knowledgeable person (a peer or an adult).

Advocates of collaborative approach claim that critical thinking is the capacity to reply productively to peers during group work, which suggests interacting in socially constructive fashion. Likewise, Heyman (2008) shows that social skills can frame children's critical skills. Nelson (1994) suggests some hints as to how cooperation can provoke cognitive abilities between college students. He mentions that students' misunderstanding interrupts their skill to

learn new information, in spite of having appropriate training. Collaborations generate opportunities to reach agreements, disagreements and to prune errors. Collaboration also is a vehicle to obtain essential assimilation to the college learning condition and supports to change implicit disciplinary structures and expectations to more explicit ones. “Collaboration must be scaffolder: first, students must be prepared for collaboration by providing them with a common background on which to collaborate, such as common assigned readings. Second, student groups should be provided with questions or analytical frameworks that are more sophisticated than they would tend to use on their own. Finally, collaborative activities should be structured by specifying student roles and by creating incentives for all group members to actively participate.” (Lai, 2018, P.18)

Collaboration

Collaboration is derived from the Latin collaborare and means to work together. Collaboration is sometimes distinguished from cooperation in that cooperation is typically accomplished through the division of labor, with each person responsible for some portion of the problem solving. Collaboration, on the other hand, involves participants working together on the same task, rather than in parallel on separate portions of the task. However, Dillenbourg et al. (1996) note that some spontaneous division of labor may occur during collaboration. Thus, the distinction between the two is not necessarily clear-cut.

In their review of the psychological and cognitive science literature, Andrews and Rapp (2015) make clear that collaboration has its own unique benefits, costs, and challenges in facilitating learning and memory. The benefits of collaboration include social, emotional and psychological well-being of the participants. Collaborative activities support achievement, problem solving, positive attitudes toward subjects, self-esteem, positive peer relations, when

compared to individual and competitive activities. There are also costs associated with collaboration; Group members while collaborating can also provide unrelated or inaccurate information, and this information can be accepted, endorsed, and incorporated into existing cognitive structures.

The benefits of collaborative activities include providing opportunities for the elaboration of knowledge, inquisitive and constructive dialogue, the co-construction of ideas, the resolution of conflicting knowledge and better information recall. Dialogue within groups discounting particular kinds of information. Task complexity is an important variable in understanding collaborative learning in groups. Students in groups solving problems of high complexity are more successful than students working alone. Not surprisingly students working alone on a low complexity task do better than students in groups. Low complexity tasks include activities which can be retrieved while high complexity tasks require retrieval and also involves relating that information to solving a problem. provides articulate explanations, strengthen existing knowledge structures and encourages the reorganization of knowledge, helps acquire new information and correct misunderstandings. One of the more salient benefits of collaboration in learning is that the process makes gaps in knowledge more salient. The discomfort generated by the collaboration helps reconcile conflicts and facilitate critical thinking.

The benefits to memory of collaboration are as beneficial as learning. Group members are exposed multiple times to more information than a person encounters as an individual. As learners encode more information during an activity, recall increases when compared to independent recall. Collaboration does improve the quality of group members production while providing feedback to each other regarding truthfulness. Andrews and Rapp use the term “error-pruning” to describe the process by which individuals engage in discarding or there are costs and

there are benefits to cooperation in group. Andrews and Rapp propose that collaborative groups share the cognitive load among group members as they coordinate, discuss and critique ideas. The coordination of group members sometimes places additional cognitive and social burdens upon the group. It is possible, of course for groups to pass on misinformation, and this suggests that the costs of passing on misinformation can be limited by monitoring, providing opportunities for critique and appropriate feedback.

General Approaches to Teaching Collaboration

Few studies investigate whether students can be successfully trained to collaborate. As Bossert (1988) observes, "specific training in cooperative roles is not offered in most studies of cooperative learning methods: The activity itself constitutes the training" (p. 227). Although, many researchers suggested applying explicit instruction in collaboration skills (Fall et al., Webb, 1995). "Teaching students social and communicative skills. Structuring tasks to support collaboration was highly recommended as well". (Bossert, Dillenbourg, 1999; Mercer, 1996; Webb, 1995).

Assessment of Collaboration

Measuring a learner's collaborative skills is a challenge. Most educators are interested in the individual's achievement score. They believe that group learning obscures the task and leaves the individual contribution unclear, making it complicated to grade each individual. Sometimes teachers will assign a single grade to a group based on completion of a group product, and this group score is given to each individual in the group; although, the effort from each individual is not equal. The score may not necessarily be a good representation of students' skills. (Race, 2001; Webb, 1995). There are four possible aims of collaborative assessments 1) Assessing each

individual skills or knowledge, 2) Assessing an individual's ability to learn from group members, which can be obtained by involving both individual and collaborative assessment elements 3) Assessing group efficiency, as shown by the result of the final project completed cooperatively 4) Teachers assessment of a student's collaboration abilities and skills. (Webb,et al,1995)

According to Webb, "if the task is well-defined and has one correct answer or solution, attempting to involve low-ability students may actually slow the group down. In this case, it may be more effective for students to work separately instead of together, for one or more group members to do most of the work while others contribute little, for one student to take control of group work if group members cannot agree, and to have minimal helping behavior" (p. 249).

According to Dillenbourg (1999) and Race (2001) increasing teacher monitoring with peer assessments of collaborative abilities and skills is helpful. Race mentions that learners are mostly a better assessor and can judge each other's work better because the learning procedures are clearer to them. Assessing a partner's job can also contribute to learning development. In order to help students to assess their own knowledge and ability, students can complete a questionnaire and submit it along with assigned group work. (As cited in Lai,2018)

Assessment

The field of assessment is wider than the field of education, it is as deep as the many disciplines within it, and it has a history that stretches back millennium. This brief sketch relies upon Hill's technical history of assessment but also includes the social political context in which changes and advances in tests and measurement take place. Hill's (2012) social political analysis of the history of assessment does not take for granted as many do that assessment is synonymous with testing. He recognizes that testing is and has been at the center of the science of

assessment. There is also no denying the field of assessment has made great advances in technical knowledge especially in the area of measurement and classification of developed abilities. Gordon (2012) argues that the field of assessment must move from the assessment of the measurement of developed abilities to an understanding of the processes of development. The social political aspects of assessment were present at its beginnings.

According to Hill this is evident when Emperor Wu in third century China instituted the first systematic use of testing as a way of checking the power of the nobles with the aim of bringing officials from the provinces into the central government. This early experiment in selection and certification began a long tradition of using tests as a means of social control. Passing the test certified that the candidate has mastered the Confucian classics as well as the skills necessary for their positions. The imperial essay exams were rigid in form and content, and applicants would spend years in preparation for the exam. Only 5% of the test takers passed the exam, and this led to the test preparation movement in which applicants were prepared through the use of successful examinations. Slowly the tests imposed such a rigorous and lengthen regimen upon the applicants that the tests also imposed a model of character.

News of the imperial exam spread to Europe, and coincided with the decline of feudalism, and tests were seen as a way of encouraging the spread of equal opportunity and democracy. By 1788 the Chinese model of testing was imported into Prussia in what is now Germany. The government commissioned the creation of the Arbitur, a test for admission to the University. The test was created to eliminate the system of patronage in which universities exacted payment from the privileged for admission to the universities. By 1812 admission tests had spread to the secondary schools in Prussia. In 1808 Napoleon decreed the establishment of the Baccalaureate degree for admission to universities. Candidates were expected to have proficiency in physics,

chemistry, biology as well as the social and economic sciences. Very rapidly entrance exams spread throughout Europe for admission to universities. Throughout Europe tests were widely accepted as a democratic instrument to insure a university system based on merit.

According to Ernest Washington (2018), the testing movement gained strength with the enlightenment emphasis upon the individual and merit. This enlightenment tradition continued from the nineteenth and into the twentieth century. In Paris, where in 1905 Alfred Binet invented the Binet Scales, the first practical test of intelligence. He had been charged by the French government with the responsibility of creating a test that identify those children who did not profit from normal instruction. He interviewed teachers and asked them, what were the tasks that successful students could do and unsuccessful students could not? The answers from teachers gave form to the first scales of intelligence. The Binet scales included six items at each age level from four to sixteen. Binet used the term mental age to describe the age at which children successfully passed the items. Those children whose mental age was below their chronological age were given remedial exercises. Binet coined the term mental orthopedics to describe his philosophy of mental development. The scale was used to identify the mental faculty of the child that needed strengthening, and teaching was the prescription to strengthen the weak faculties.

American social scientists also embraced the myth of a meritocracy that began with Thomas Jefferson who envisioned a public-school system which would educate the citizenry. This citizenry, of course, excluded those men without property as well as women and Black people. World War I brought on the draft and the need to select men for the armed forces. In 1914 Frederick Kelley, Dean College of Education at the University of Kansas introduced multiple reasoning tests as a means of testing. At about the same time Robert Yerkes, President of the American Psychological Association convinced the U.S. Army to use the newly invented Army

Alpha Test, to test the intelligence of recruits. The Army Alpha developed by Arthur Otis and Lewis Termen was used to select service members to serve in certain units in the armed forces. The development of machine scoring made tests widely available and reified the objectivity of the tests. In 1926, the College Entrance Examination Board implemented the Scholastic Aptitude Test(SAT). By the 1930s multiple reasoning tests and their offspring, true false tests were widely accepted in schools.

Termen was later involved in the adaptation of the Binet scales into the Stanford-Binet Test of intelligence in which the concept of I.Q. become synonymous with the concept of intelligence. The concept of I.Q. was simply mental age divided by chronological age and multiplied by one hundred. The resulting single number rapidly became synonymous with the development and measurement of intelligence.

Testing and research on race ignited a firestorm in the 1960s and brought about charges of racism and turmoil. Until 1960 America was an apartheid state, and tests and measurements confirmed what most white people knew, Blacks were an inferior race. These latent sentiments came to the surface when Nobel Prize winner, James Shockley, enlisted Arthur Jensen (1968) to accept funds from the Heritage Foundation to conduct research and report his findings on race. Jensen's 128-page review of the literature on I.Q. testing, in which he claimed I.Q. differences were genetic and could not be ameliorated by social policies, set off protests at Harvard and the University of California at Berkeley as well as other universities. The protests had a chilling effect upon research at universities and the testing industry.

A generation later, protests over high stakes testing, began to rock the testing industry. This time the protesters were not blacks and liberals but middle class white parents who were protesting the impact of high stakes testing upon their children. The turn of the twentieth century

marked the ascendency of the testing industry and widespread controversy about high stakes testing. This controversy is reflected in the tension between formative and summative assessment functions, that is, assessment to support learning and assessment for certification and accreditation, although these are not separate or fixed paradigms (Wiliam and Black, 1996).

Currently, formative assessment is the objective and sanitized version of assessment and summative assessment has come to represent all social aspects (Scriven, 1967,p.42). Differences, claims and counter-claims about the functions of summative and formative assessment has been continuous. Despite the support by Black and Wiliam and the Assessment for Reform group suggesting that the two types of assessment are inseparable (Black and Wiliam, 1998; Wiliam and Black, 1996; Wiliam 2000) notes that the differences may not be reconcilable. Torrance and Pryor (1998) notice that little actual research has been done on the relationship between summative and formative research while there has been a great deal of theorizing about functions: this comparison however focuses almost exclusively on the functions of assessment.

Formative assessment is more time consuming, expensive and less reliable in scoring. The growing endorsements, approval, and prominence of formative assessment is due in part to the dissatisfaction with summative assessment which does not capture the complexities and individuality of the competence of the individual. (Jacobs & Farrell, 2003, pp. 19-20)

Alternative approaches to assessment became a credible reform movement in the early 1990s and continues into the 21st century by emphasizing formative assessment, procedural knowledge, cognitive, social, emotional relations, relationship between students and teachers, and the development of intellective competencies. These reformers are concerned with moderating the negative impact of summative evaluation and judgments about the knowledge and potential of students. This movement expanded inquiry beyond declarative knowledge to

embrace procedural knowledge to include knowledge of the self, knowledge of the other and knowledge of the social world. Advocates of alternative assessment are quite willing to consider diverse ways of gathering knowledge that go well beyond testing to include portfolios, classroom artifacts, and place emphasis upon student directed learning.

The tensions between formative, summative, and alternative approaches to assessment have given way to mixed method methodologies as the methodology of choice in the educational assessment. Mislevy's model (2012) is a natural extension and mix of methods in the development of methodologies of assessment. He offers, four metaphors we need to understand assessment. He begins by commenting that everyone agrees the improvement of assessment is critical to making progress in educational practice and policy, and yet conversations about improvement pass each other like ships in the night. Each theory of evaluation is safe in its own ship and cannot see the connections with others going in the same direction. He offers four metaphors that he believes will improve communication between theories: assessment as practice, assessment as Feedback Loop, Assessment as Evidentiary Argument, and Assessment as Measurement. He is not quite finished when he lists these metaphors, he has four other metaphors that will complete his lists of essentials for a science of assessment. His four additional metaphors are: tests as contests, Assessment Design as Engineering, Assessment as the Exercise of Power and Assessment as Inquiry.

It is this desire to suppress the negative and destructive side effect of assessment which devalues personal worth and future prospects, that has prompted many educationalists to see summative assessment in a negative light and promote formative assessment (Torrance, 1993; Sebatane, 1998; Black and Wiliam, 1998; Wiliam, 2000; Torrance and Pryor, 2001: 624; Black et al., 2003). Society at large naturally, and rightly, makes judgements; the misuse of these

judgements does not invalidate or minimize their necessity. It seems that the very fear of the possible social misuse of assessment has distorted our view of it (Scriven, 1967,41).

3AM MODEL

The language game of critical thinking (LGCT): A method to teach critical thinking

The LGCT is a language with a syntax of "what, when, where, how and why". Like most languages the language games of critical thinking has a syntax, semantics, and pragmatics. Each of these aspects of language illuminate different dimensions of the language of critical thinking. The LGCT are the theoretical link between the learning of individuals and learning in groups. As a result, the LGCT are also a link between the individual and the collaborative phases of the M3CA model.

The six "WH questions" collectively provide information for understanding a narrative. Answers to each question is a declarative statement that provides different information. The critical thinking "WH questions" are deceptively simple, singular, and important sources of information. These singular language games merge together into the development of the language games of critical thinking. The games of thinking may start with "who, when, what, where, how, where" and novelists and scientists alike begin inquiry from these different perspectives. The focus upon a single "wh question" misses the point that much of information sharing involves the serial application of the "WH questions" to a problem.

The LGCT is the 3CAM approach to understanding the language games of thinking. The idea of a language of thought (LOTH) dates back to Fodor (1975) who introduced the concept of a computational theory of thought. His proposal listed a series of requisites if a theory of the

language of thinking was to be viable. His proposal is over forty years old today, and advances in philosophy and cognitive science have strengthened the case for a language of thinking. He proposed that a language of thinking must account for 1) the nature of thought, 2) the nature-nurture issue, 3) account for the empirical evidence for against language of thought, 4) the scope of the language of thought and the role of intentionality. Fodor's ambition was to account for the entirety of landscape of thinking.

The M3CA makes the more modest claim that the "WH questions" are the basis for the language games of critical thinking. The analysis of the syntax, semantics, and pragmatics of the LGCT is a useful way to answer the questions raised by Fordor and to point toward future research.

The premises of the language games of critical thinking(LGCT) is that the language games of critical thinking have a syntax, pragmatics and semantics. The LGCT begins with Chomsky's assumption there is a language function or faculty and that all human beings have the ability to learn any of the world's languages. The first topic to be taken up is the syntax of the LGCT and the nature of thought. Pragmatics includes not only the meaning of a word or question but also an account of the social circumstances. In the case of LGCT the circumstances include the nature of the learner and a developmental approach to meaning. Semantics includes the traditional topic of meaning of the question, answer, word but also the meanings of images, feelings, as well as thoughts.

Syntax

According to Berwick and Chomsky (2016) the basic premise of syntax includes a merge function that builds a discreet infinity of structured expressions that are interpretable in a definite way by the conceptual-intentional system of thought and action, and by a sensory motor system

for externalization. Another way of putting it is that from a finite combination of expressions and infinite number of possibilities. Merge occurs when two syntactic components are combined into a new unit (a set). Recursion is one of the properties of syntax and it occurs when it applies to its own output: the components combined by merge form a new unit and throughout which the original component remains.

The critical thinking questions of "what, why, when, where, how, and why" are the basic components of a language of critical thinking. Like all languages the LGCT has a syntax. The syntax pf the LGCT is simple and yet powerful. There are two pivot words, "why and how", and there are four open ended words "what, where, and when". There is no strong empirical evidence to date as to the answer to the empirical question, is there evidence that the six "WH questions" have a syntactic structure? A strand of evidence is to be found in this dissertation. An examination of the statistical interactions of the frequency (use) of the pivot words and the infrequency of the open words (questions) will give some indication of the presence of a syntactic relationship.

The components of "why, when, where, how, and what, who" are finite in number and generate an infinite number of possibilities. There remains the empirical question of "is there a merge function during the application of the "WH question" to a series of problems over a period of time?"

Pragmatics

The pragmatic dimension of language learning is a reminder that language is a social activity. Collaboration is at the heart of the M3CA model and capitalizes on the necessity of social activity for the development of the language games of critical thinking. The individual and

collaborative phases of the model take advantages of individual and collaborative learning. Students create their concept maps-questions, and for the first time they have a picture of their uniqueness as an individual thinker. Later they exchange concept maps and they see the representation of the thinking of a team mate. They exchange concept maps, and a new question arises, is there a synthesis of their knowledge? Notice the concept of synthesis bears a family resemblance to the concept of merge.

There is a small literature on individual children learning to use questions, and that literature will be briefly reviewed. There is no literature on the collaborative uses of the critical thinking questions. Scardamalia and Bereiter (2012) emphasize that in the coming decades team learning and not individual learning will be the focus of attention. They want to go beyond collaboration to cognitive responsibility for team learning. They make their case by beginning with the observation that all learning is group learning. Their emphasis is on what they call cognitive responsibility which can be described under the rubric of team learning while including a shared commitment to achieving a goal or completing a task.

It is important to begin with a brief discussion of the individual use of critical questions by children to provide a baseline for the use of critical thinking questions. Pinker (2003) describes children as intuitive psychologists who recognize the intentions before they copy them. If children recognize that an action was not intentional, they will not pay attention or imitate it. The minds of children are fitted with mechanisms to copy and imitate the intentions of others, and this is so ordinary. The motivation to be like others fuels the need to benefit from the information and knowledge of others and the second is normative, the desire to follow the norms of a community. Learning to ask questions is a normative experience that children learn and imitate.

The desire to acquire knowledge is present in children between two and five years of age as they learn the language games of question asking. According to Chouinard; et al, (2007) children use an average of 107 questions an hour when engaged in conversation with adults. These youngsters are using language and conversation in a purposeful and intentional way to gather information, fill in gaps in their knowledge.

Ruggeri, Sim and Xi (2017) investigated how preschool children used question asking to explain, why is Toma late for school? They compared hypothesis-scanning questions with constraint-seeking questions. Hypothesis-scanning questions target single objects within a given set such as, can this dog be found on Planet Apres? Constraint-seeking questions target a category or a feature shared by multiple objects such as "Can animals be found on Planet Apres"? Constraint-seeking questions are able to rule out alternative hypotheses and therefore are usually considered more effective than hypothesis scanning questions. As a result of their experiments they found that children become more proficient at generating constraint seeking questions because they are more proficient at categorization, verbal knowledge and previous experiences.

Bereiter and Scardamalia (2012), remind us that are continuities and discontinuities when moving from the individual to group analyses of learning. They use the concept of cognitive responsibility to capture a wide range of group phenomena that capture shared knowledge, beliefs, intentions, goals, and understanding. Cognitive responsibility is already shared by research, design and planning teams. Accordingly, they speculate that it is difficult to imagine the assessment of these complex social undertakings without computer technology. Such technologies will provide teachers and students to monitor levels of participation and discourse

in knowledge building. In the future, they claim to see the evolution of ideas. In this era leaders will be able to facilitate but not necessarily control and manage the processes of learning.

Semantics

At the individual level semantics is concerned with the meaning of words, images, gestures and/or questions. The figure below captures the traditional view of the nature of semantics. Asking a question (always occurs in a certain context) and this question requires an appropriate answer. This answer of course, if it is to have meaning, must connect to the reality of the world. The connection between the answer and the world is the correspondent definition of truth. There is much debate about this simple scenario, and it remains after a century of debate.

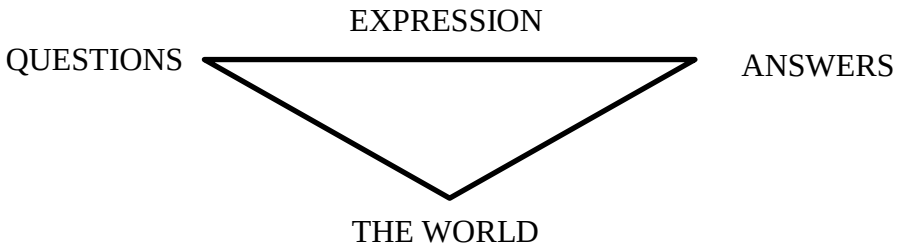

Figure 2: Semantic relations

A useful question is one that elicits an answer in accord with the world. Useful hypotheses in a science lab produces answers that are in accord with the facts about the world. The great detective Sherlock Holmes used questions and answers to solve the great mysteries of the world.

Conclusion

The LGCT is a systematic way of assessing the patterns of questions used by students in solving problems. The trajectory of critical thinking WH questions “what, why, when, who, where, and

how" can each be traced over time. The measurement of the critical thinking question over times provides a dynamic view of the processes of thinking. Students come to class with established patterns of using only one "WH question" in their approaches to inquiry. It is possible to use educational strategies, suggestions and directions to alter the established trajectories of critical thinking.

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