Transforming Diverse Learners through a Brain-based 4MAT Cycle of Learning

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Abstract -The shift in the learning paradigm of the teaching–learning process, from teacher-directed to learner-centered, has inspired the researchers to explore the 4MAT Teaching Cycle. This study premised itself on three foundations; a) Individuals receive and process experiences in different ways, b) Using both right and left brain processing techniques ensures the education of the whole person, and c) There is a need to unite the learner's experiences and body through a method of thinking and doing. The study aimed to find out the influence of the approach on the behavior, attitude and academic performance of the students. A descriptive qualitative method of research was utilized with second year engineering students at Mapua Institute of Technology first quarter of SY 2009-2010. The different phases of the 4MAT cycle of learning dealt with diverse learners that included Direct Experience, Reflective Observation, Abstract Conceptualization and Active Experience. As the students moved from one phase to the next in the cycle, changes in behavior were observed and reported, notably active engagement in the activities, participative inquiry and collaborative discussion. Certain theories and principles served as foundation for the approach. These were constructivism, law of practice, readiness, brain-based theory and learning styles. Individuals utilized both right-brain and left-brain processing techniques which ensured the education of the whole person. The results gathered from survey questionnaires, rating scale, observations and interviews showed that with the 4MAT cycle of learning, the students developed certain habits of mind and attitude. These habits included openness and respect for the opinion of others, creativity and perseverance in finding solutions to problem, patience in finding additional information to solve the problem, and commitment to learning and responsibility for one's learning. Finally, the study guided teachers and school administrators to develop appropriate programs particularly on how to assist students in developing a learning repertoire.

Index Terms - diverse learning, perceiving and processing of information, direct experience, reflective observation, conceptualization, active experimentation

1. INTRODUCTION

Education is a process of leading, guiding, and teaching the learner. It is not simply a matter of memorizing a number of facts, but of knowing what to do with those facts. However, this does not imply that teachers should stop teaching facts altogether nor train students to stop memorizing facts, but rather to teach them to sort, classify, categorize and utilize them at a conceptual level. These are both necessary elements of learning.

Moreover, Parry and Gregory (1998) stated that learning is a search for meaning and it takes place when a new information is connected at the neural level to an information that already has meaning or relevance to the learner. The more closely the new information conforms to what the learner perceives as interesting, useful and emotionally stimulating, the more likely it is to be integrated and learned. A case in point is the research endeavor. Students do not appreciate this critical thinking activity, but if it is connected with something important to them, they will find the task interesting and stimulating.

Generally, learning has its emotional element. When the emotions are engaged, the brain releases neurotransmitters that mark the event and make it important. This focuses attention and facilitates learning. The brain, emotions, body and learning are interdependent. Why do we have underachieving students? Not because they have low mental abilities. It is a result of many factors, among which are instructional procedures and teachers. To the extent that the learner likes the teacher; the learner will like the subject. Educators who understand what it takes to stimulate their learners touch the hearts of their students even before they touch their minds.

To answer the need for a holistic approach in teaching Mathematics, the researcher pursued the study which centered on a brain-based constructivist premise of learning. Eclectic as it is, this approach has been termed 4MAT Cycle of Teaching espoused by McCarthy (2006) and is comprised of a cycle of instructions that address and challenge all learners.

II. REVIEW OF RELATED LITIRATURE

Decades ago, teachers had the assumption that the quality of learning depended solely on the expertise of the information-giver, the teacher. With this premise, greater emphasis was on the improvement of the teachers and their knowledge of instructions: how to teach a course. Later on, this paradigm shifted to the assumption that learning depended on the student's frame of mind; thus, focus was turned on the creation of a conducive learning environment and learning communities. Such environment gave the students opportunities to a) seek new knowledge and make new

discoveries, b) master new skills for dynamism, c) ask questions so they would improve, and d) perfect old skills needed for life- long learning.

This paradigm shift in the teaching- learning process has its dependence on the student's positive frame of mind. This term is used to imply commitment to and passion for learning as teachers possess the commitment to and passion for teaching. Commitment to and passion for learning is manifested in the students' feeling of the excitement of learning (emotion), pricing the connection between what they learn and what they understand (brain, emotion), and appreciating the intrinsic worth of learning something well (motivation and value). To this end, the students are able to recognize their responsibility to understand the world they will manage in the future. This possibility can be achieved in an environment where students are likely to be cared for and respected, where what they can do matters more than what they can not do, and where there is a non-threatening atmosphere. Such environment also gives opportunities for students to explore the subject matter with the teacher. The teacher and the students become co-learners and collaborators in search of new knowledge; students are heard and they receive answers to their queries. Thus, teachers need to come together to talk about how they can understand and teach students better using the modalities which facilitate the latter to learn more (LS) and allow them to utilize their preferred way of expressing their knowledge about something (MI). This new perspective, a new paradigm, is an element which is embedded in 4-Mat Cycle of Teaching espoused by McCarthy (2006), a cycle of instructions that addresses and challenges all learners.

This approach is based on a number of premises. First, different individuals perceive and process experiences in different preferred ways. These preferences comprise the unique learning styles of the learners. Through experiences with alternative modes, learners can be helped to develop a learning repertoire. Students can be helped to move from one mode to another to fit the requirements of the situation. Second, individuals utilize either the left brain or the right brain but using both right and left brain processing techniques ensures the education of the whole person. Third, as Dewey postulated, there is a need to unite the student's experiences and body through a method of thinking and doing. He stated that human experience is the gateway to understanding.

The 4MAT learning Approach is a cycle of learning processes which addresses the learning styles and brain- based learning issues as the process begins and ends with the learner himself/herself. The cycle begins with the learners as a new learning or experience is being introduced. Termed as the direct experience (DO) phase, the learners are embedded in the web of their own learning. They experience the NOW as they connect to themselves their knowledge, feelings and the impact of the activity that the teacher creates. In this phase, the students are led to discover their own reactions, to relive their own experiences, and even to listen to an inner voice.

This is followed by a reflective observation (RO) of one's experiences and the new learning. This is what experts call the listening time wherein students are engaged in an ambiance of attuned and active listening. The learners cross the bridge from the world of self to the world of the experts as they listen to lectures, read and examine literature. Teachers tell the facts and information in a varied fashion to suit the students' background and level of understanding.

The third phase allows for abstract conceptualization (AC) wherein students think, examine and focus their attention intellectually on the new learning. This is where learning really begins. Students try out things, experiment individually, in groups or in teams. The teacher becomes a coach, a facilitator, a guide as students pose questions and undergo practice for mastery. The students learn how valid the learning is for them and they use the learning in their own lives.

The purpose of phase four is to have students adapt learning to their lives, to use it and allow the new learning to influence the future. The students empower themselves as they extend their learning. They refine the use of what they learn and integrate it into their lives. The key is adaptation to new settings, to new situations. Alternative assessment is necessary to cover a wide range of unique outcome inherent in the new learning. The students are informed of how the new learning will be measured when they are asked to perform it. Throughout the cycle, the students have the personal meaning of learning.

Embedded in this approach is the constructivist's theory which explains that each new learning combines prior experience and first hand knowledge gained from new explorations to understand something in greater depth. It posits that learning is continuous and an individual process because one brings to each learning experience, a personal style, a personal history and a developmental level.

Prior Knowledge and Cognitive Development

Notice that the students' prior knowledge and experience at home, in school, and in the community play a key role in the initial phase of the learning cycle. This is so because learning is an active process in which a student builds knowledge and links new bits of information and experience to internal circuits known as structures or schemata. Interestingly, neurological studies (Wolfe & Brant, 1998) have shown that a collective group of developed pathways or neural network becomes a map of how a learner thinks, reasons, and remembers. The more this pathway is used, the more it becomes sensitive and developed. Non-use of these connections or pathways can result to loss of pathways in between and soon the pathway becomes unusable. This is a biological explanation of Thorndike's Law of Use and Disuse. There were researchers who did local studies on the role of prior knowledge and experience in academic achievement. One will realize that the definition of learning itself stresses the importance of experience in bringing about change in behavior. Such change in behavior may not take place until sometime after learning has taken place. It would also be worthwhile to mention that aside from the skills and knowledge, students also bring with them attitudes and values that have been shaped by prior experiences.

The Social Cognitive Theory

Another interesting theory on learning and development is that of Albert Bandura (1989). Bandura has defined human behavior as a triadic, dynamic, and reciprocal interaction of personal factors, behavior, and the environment.

According to this theory, an individual's behavior is uniquely determined by each of these three factors. While the Social Cognitive Theory upholds the behaviorist notion that response consequences mediate behavior, it contends that behavior is largely regulated antecedently through cognitive processes. Therefore, response consequences of a behavior are used to form expectations of behavioral outcomes. It is the ability to form these expectations that give humans the capability to predict the outcomes of their behavior before the behavior is performed.

Bandura viewed people as self-organizing, proactive, self-reflecting and self-regulating rather than as reactive organisms shaped by environmental forces or driven by concealed inner impulses. From this perspective, human functioning is viewed as the product of a dynamic interplay of personal, behavioral, and environmental influences. Hence, this is the foundation of Bandura's (1986) conception of reciprocal determinism: the view that (a) personal factors in the form of cognition, affect, and biological events, (b) behavior, and (c) environmental influences create interactions that result in a triadic reciprocity. He emphasized that cognition plays a critical role in people's capability to construct reality, self-regulate, encode information, and perform behaviors.

At the core of this theory are self-efficacy beliefs or learners' judgment of their capabilities to organize and execute courses of action required to attain designated types of performance (Bandura, 1997). He further stated that efficacy beliefs provide the foundation for motivation, well-being and personal accomplishments. Unless people believe that their actions can produce the outcomes they desire, people have little incentive to act or to persevere in the face of difficulties. As learners put it, "I have to work hard to pass this course." These self-beliefs and perceptions help determine what individuals do with the knowledge and skills they have acquired. This explains why people's behavior is sometimes disjoined from their actual capabilities or potential performance. In fact, there are students who are confident of what they can accomplish despite their modest repertoire of skills; there are also many talented learners who suffer moments of self-doubt about capabilities they clearly possess. But definitely, no amount of confidence can produce success when prerequisite skills and knowledge are lacking or absent. These self-beliefs therefore enable learners to exercise a measure of control over their thoughts, feelings, and actions. These self beliefs that people have are critical elements in the exercise of control and personal agency. Thus, individuals are viewed both as products and as producers of their own environments and of their social systems.

Within this social cognitive perspective is the understanding that individuals are imbued with certain capabilities that define what it is to be human. Primary among these are the capabilities to symbolize, plan alternative strategies (forethought), learn through vicarious experience, self-regulate, and self-reflect. These capabilities provide learners with the cognitive means by which they are influential in determining their own destiny.

This theory also states that learners possess an extraordinary capacity to *symbolize*. By drawing on their symbolic capabilities, they can extract meaning from their environment, construct guides for action, solve problems cognitively, support forethoughtful courses of action, gain new knowledge by reflective thought, and communicate with others at any distance in time and space. For Bandura (1997), symbols are the vehicles of thought. By symbolizing their experiences, learners can provide their lives with structure, meaning, and continuity. Symbolizing also enables people to store the information required to guide future behaviors. It is through this process that they are able to model observed behavior. Through the use of symbols, individuals solve cognitive problems and engage in self-supervision and *forethought.* People plan courses of action, (like reviewing before examinations), anticipate the likely consequences of these actions, and set goals and challenges for themselves to motivate, guide and regulate their activities. It is because of the capability to plan alternative strategies that one can anticipate the consequences of an action without actually engaging in it.

People learn not only from their own experience but by observing the behaviors of others. This vicarious learning permits individuals to learn a novel behavior without undergoing the trial and error process of performing it. In many situations, it keeps them from risking costly and potentially fatal mistakes.

Individuals have self-regulatory mechanisms that provide the potential for self-directed changes in their behavior. The manner and degree to which people self-regulate their own actions and behavior involve the accuracy and consistency of their self-observation and self-monitoring, the judgments they make regarding their actions, choices, and attributions, and finally, the evaluative and tangible reactions they make to their own behavior through the self-regulatory process. This last subfunction includes evaluations of one's own self (self-concept, self-esteem, values) and tangible self-motivators that act as personal initiatives to behave in self-directed ways.

Learning Styles Theory

Learning style can be defined as the usual or characteristic manner in which a learner goes about the task of learning (More 1987). There are various approaches to learning style that can be described as processes on a continuum. Theses approaches are not mutually exclusive; they represent different ways of viewing complex phenomena.

Among these processes are:
(a) global/analytical (More 1984)
(b) impulsive/reflective (More 1976)
(c) field dependence/field independence (Witkin et al.1977)
(d) simultaneous/sequential processing (Kirby 1984)

As style is concerned with very complex issues involving cognition, conceptualization, affect, and behavior (Guild & Gerger 1985), it is not surprising that various learning-style models exist. Each model typically focuses on a single aspect within this multidimensional set of factors (Guild & Gerger 1985). Given the diverse learning-style models and instruments (Keefe, et al. 1979), a model that is sought has a

practical as well as conceptual value. Kolb's experimental-learning model meets both requirements because of the availability of an excellent classroom application of the model by Bernice McCarthy (1980) in the 4MAT System: Teaching to Learning Styles with Right/Left Mode Techniques.

Kolb (1984) acknowledges that his theory is eclectic, and that its applications are drawn from the work of John Dewey, Kurt Lewin, Carl Jung, Jean Piaget and Lev Vygotsky. He states further that "learning styles are the result of our hereditary equipment, our particular past life experiences and the demands of present environment." Kolb found that "it is the combination of how people perceive and how people process that forms the uniqueness of 'learning style'-the most comfortable way to learn". By combining two dimensions of concrete experience and abstract conceptualization ("how we perceive") with two dimensions of active experimentation and reflective observation ("how we process"), Kolb established four categories of learning styles based on four learning modes (Kolb 1984).

According to Kolb, effective learning involves four phases: from getting involved (Concrete Experience) to listening/observing (Reflective Observation) to creating an idea (Abstract Conceptualization) to making decisions (Active Experimentation). (See Figure 1.) A person may become better at some of these learning skills than others; as a result, a learning style develops.

III. CONCEPTUAL FRAMEWOKR

The framework on which the study has been based shows the different four phases of the 4MAT cycle of learning which have been exhaustively explained in the review of related literature and procedure. The second set of variables explains the influence of the new approach to teaching on the students' performance, behavior and attitude.

In Direct Experience, the students are drawn to something new and they become immersed in it. They are caught in the web of their own meaning. They ask WHY? Almost immediately, they begin to filter their own experiences through who and what they are and their past experiences. They internalize the newness in the schemata of their personal world. They release their subjectivity only to become objective later. This is the Reflective Observation phase. This is followed by Conceptualization where students appraise the newness, ask WHAT and later symbolizes it by naming it. They look at what others, especially the experts, say about it and what they have done about it. Getting to know and understand drives the students to try it and make it work. They see HOW others do it , then do it their own way. Students continue to use it and ask IF as they learn to transfer the learning, adapting it to new situations and make something new of it. Finally, the students become enriched by the new learning and they are transformed.

For each phase, activities can be drawn to suit the situation and the purpose. They are not simply meant to supply people with information, but to help the students think and learn well.

IV. STATEMENT OF THE PROBLEM

The study explored the use of 4MAT approach in teaching applications of first order first degree differential equations. Specifically, it sought answers to these questions.

1. What are the phases of the 4MAT Teaching Approach? What changes take place in the students as they move from one phase to the next?
2. What theories and principles of teaching influence 4MAT Teaching Approach? How do they influence the teaching approach?
3. How does the 4MAT Teaching Approach influence the students' behavior, attitude and academic performance?

V. RESEARCH DESIGN

A descriptive qualitative method of research was utilized with second year engineering students at Mapua Institute of Technology first quarter of SY 2009-2010. It investigated the qualitative descriptions and characteristics of the groups under study and looked into the conditions that existed, the practices that prevailed and the beliefs that were going on in teaching the basic courses. It also included the causes and effects that influenced the subjects' feelings due to the conditions, practices and beliefs involved in the teaching-learning process.

VI. RESERCH INSTRUMENTS

There were two instruments used in the study; the rating scale and the survey questionnaire. The rating scale was utilized to find relevant information on the perceived changes in the behavior and learning of the students as they moved from one phase to the next. The survey questionnaire was utilized to look into the degree of influence of the teaching technique on the learning attitude and behavior of students

VII. PROCEDURE

The study was undertaken following this sequenced procedure.

1. Orientation to the approach - This step had to be undertaken to reduce anxiety and clarify expectations, roles and goals. In this phase, a new method of assessing the process and output/product was also introduced. Due to time constraint, the researcher presented pre-constructed rubric guide on oral presentation and group work. The students gave suggestions on the grade range and descriptors; thus, ownership was established. The scoring rubric grids served both as instructional and evaluation tools because the students were given standards of performance which they had to attain while doing their work. The researcher, who is the class professor himself, recorded the students' participation and reaction throughout the sessions. He noted behavior and attitudes of his students on his teaching journal, a "must" for him to become a reflective educator. Furthermore, the students were also required to write in their journal their observations, insights and behaviors on different activities.
2. Grouping of students - Students were divided into groups of 6. For this initial endeavor, the students were allowed

to choose their group mates to facilitate interaction and carrying out of roles and tasks. The facilitator and recorder for each group were chosen. The facilitator took charge of the discussion, task delegation and monitoring of work progress. The recorder records the activities, results of discussions and progress of work.

3. Implementing the approach

Direct Experience - A problem trigger or an "ill-structured" scenario was presented to the group. This problem embedded previous knowledge but did not contain all information needed to solve it. This simply meant that they had to gather necessary information or learn new concepts, principles, or skills as they engage in the problem-solving process. Each group read, discussed and analyzed the problem. They discussed information which were explicitly found in the text/problem trigger---those which were not known, what they had to know and what they had to do. This phase utilized basic Reading and Metacognitive Strategies:

K – What is known
W – What they want to know
L – What they have to learn
A – What action to do

The students were given the opportunity to retrieve information which they had learned(K). With this knowledge, they were able to find the gaps and discrepancies in the problem trigger (W). The students realized that they had learned something in the past which they were ready to employ in finding the solution to the problem (constructivists' theory). They were motivated to plan (learning to learn) what they had to know and to do to solve the problem. Presented with a problem, students had to look for information to fill in the missing gaps (L) and to list possible actions, recommendations, solutions, or hypotheses (A). Students listed actions to be taken and formulate and test tentative hypotheses. In summary this stage constituted:

a. Presentation of a new situation which involved mathematical problem.
b. Brainstorming on the problem or situation; finding possibilities on the various angles on how it can be solved
c. Relating the problem to situations learned in class or experienced in life
d. Discovering future use for the problem

Reflective Observation - This phase gave opportunities for the students to carry out their plan; to search for new information. They reviewed their previous lessons, read new information from the books. It was worth mentioning that some students gave information/ideas which had not been thoroughly discussed in their lessons. The students visited the website developed by the researcher for additional information. In one of the sessions, the researcher invited teachers of the Physics Department who gave input on Newton's Second law of Motion. This was also a method employed for the Breakout activity which the researcher termed as Peer Teaching or Collaborative

Abstract Conceptualization - This phase allowed the learner/students to go over their new information; to sort them out (relevant and irrelevant) and organize them for presentation. This phase included:

Active Experimentation - The students presented their solution to the problem trigger. The professor required students to communicate, orally and/or in writing, their findings and recommendations. They presented the information given by the problem, the information they needed to know and what they had gathered to solve it. They gave clear information as to how and why certain steps and solutions were undertaken and arrived at. The product included the problem statement, questions, data gathered, analysis of data, and support for solutions or recommendations based on the data analysis. The students presented also the graphic organizers they constructed in class and these were evaluated using a scoring scheme. There is a growing body of research that shows that when students construct graphic organizers and work in small groups and cooperate in striving to learn subject matter, positive cognitive and affective outcomes result.

Evaluation - During the presentation stage, students in Experimental Group were also evaluated utilizing the scoring rubrics grid as an alternative assessment tool. This was in addition to the paper and pencil pretest which were also given to the control group.

Since this was an innovative approach which was implemented initially, the researcher modified the steps based on time element (quarterly instead of semestral) and ways (initial use instead of a regular strategy). It is also noteworthy to mention that this is a transformative eclectic approach. The orientation and closure were added. This was resorted to so that the learners would be prepared (Law of Readiness, by Thorndike) to undertake the new activity with an entirely new process in a less stressful environment or setting. The closure reinforced the positive response and good performance of the students during the entire activity. Skinners Operant Conditioning Theory states that if the consequence of an act is satisfying, the probability of repeating the act is greater.

It should be noted that the pretest was administered before the preparatory stage and the posttest was administered after the MetaMath intervention. Furthermore, Group A, the control group was subjected to the usual lecture-practice-test method.

VII. FINDINGS

1. The students strongly agree that during the first phase, they are able to connect their past experiences with the new problem presented. Furthermore, they are also led to encouraging discussions among themselves, sharing personal experiences which are very much related to the problem being discussed. This puts into use the constructivist point of view that students formulate schema based on their previous knowledge and experiences.

2. Students strongly agree that they raise questions pertinent to the problem to explore the relationships among the various aspects of the problem. Furthermore, they also agree that they keep on looking back at major concepts related to the problem as they pursue their discussion. Students become more emotionally engaged in the process because they themselves are able to work on the problem without the interference of the teacher. They have a sense of wonder as they explore together looking at ways to solve it.

3. Students strongly agree that they enjoy the activities as they learn-by-doing; reading related facts, asking the experts, listening to resource speaker, testing possible solutions too. Students learn best when they participate in the activity and discover for themselves new learning. They learn to ask themselves what they still have to know to work on their problem and at the same time design their plans in accomplishing their tasks. This manifests metacognitive learning as students monitor their own learning.

4. Students strongly agree that they have been given ample opportunities to see how the solution could work well in various situations. They also agree that they have been evaluated on the task based on what they have agreed upon. Thorndike has expressed that learning becomes more permanent with practice and drills. With 4 Mat cycle of learning, students are given ample experiences to master and apply a new learning in various situations.

5. In addition to the rating scale, data from the survey questionnaire reveal that the students have developed certain habits of mind and attitude that have contributed to their improved output. These habits of mind include openness and respect for the opinion of the group members, creativity and perseverance in finding solutions to the problem, patience in finding additional information to solve the problem, commitment to learning, and responsibility for one's learning.

Hence, the posttest mean scores of the students in Group A is significantly higher compared to their pretest mean scores, thus learning takes place after the students are subjected to the traditional lecture-discussion method. For Group B, it has to be noted also that there is a significant difference between the pretest and the posttest mean scores of the students in favor of the posttest scores, thus learning also takes place after the students are subjected to the 4MAT Teaching Approach.

It is noted that there is a significant difference between the posttest mean scores of experimental group one and the control group one as revealed by $F = 181.325$, DF= 1,77, $P \leq 0.001$ for lesson one and $F = 168.987$, DF= 1,77, $P \leq 0.001$ for lesson two. This implies that the teaching approach is more effective than the lecture-discussion method of presenting both the lessons after the pretest scores of the students have been made constant.

VIII. CONCLUSIONS

Based on the findings of the study, the following conclusions were arrived at:

1. The different phases of the 4MAT cycle of learning included Direct Experience, Reflective Observation, Abstract Conceptualization and Active Experience. As the students moved from one phase to the next in the cycle, changes in behavior were observed and reported, notably active engagement in the activities, participative inquiry, collaborative discussion and designing, and respect for each other.

2. Certain theories and principles served as foundation for the approach. These were constructivism, law of practice, readiness, brain-based theory and learning styles. Through experiences with alternative modes, learners were facilitated to develop a learning repertoire. Students moved from one mode to another to fit the requirements of the situation.

Individuals utilized both right- and left-brain processing techniques which ensured the education of the whole person. As Dewey postulated, there was a need to fuse the students' experiences into their physical body.

3. With the 4MAT cycle of learning, the students developed certain habits of mind and attitude. These habits of mind included openness and respect for the opinion of the group members, creativity and perseverance in finding solutions to the problem, patience in finding additional information to solve the problem, commitment to learning and responsibility for one's learning.

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