ENHANCING METACOGNITION THROUGH THE USE OF MULTIPLE INTELLIGENCE

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CBI	Computer Based Instruction
CTA	Cognitive Task Analysis
ES	Effect Size
MI	Multiple Intelligence
TIMI	Teel Inventory of Multiple Intelligence

CHAPTER I

INTRODUCTION

Previous research has proposed that young children have innate abilities to manage their learning (Vygotsky, 1998). However, it is questionable whether or not traditional educational systems nurture, support, and encourage the enhancement of this natural ability. Theoretically this could help explain a young child's ability to absorb new information, use, and retain it, rapidly mastering new skills (Piaget, 1928).

This rapid learning phase appears to be at its peak from ages one to five. Educational potential in the form of IQ is usually measured and monitored after age five (Gardner, 1993a). The learner's environment at all levels demonstrates and expands on these innate capabilities and should be supportive of the natural cognitive capabilities. A supportive environment enhances and supports the student's progress while achieving academic goals (Strange, 1994). Fuqua and Kurpius (1993), stated that, "human organizations are potentially very complex systems operating in even more complex environments" (p. 607). Beil and Shope (1990) stated that "although the characteristics of the students are important, what happens after they enroll in the college appears to have a greater impact on persistence" (p. 11).

Astin (1975) has concluded that a student's chance to successfully progress toward completion of a college degree can be significantly influenced by environmental circumstances. The college experience fosters the student's growth moving them toward becoming well-rounded problem solvers that bring skill and ability that have a positive impact on society.

Extensive research has been done on student success (Astin, 1975; Bean & Bradley, 1984; Dey & Hurtado, 1995; Pascareua & Terenzini, 1991). Research pertaining to student success includes several factors including personal, social, environmental, and economic concerns. Each student entering college is a unique individual bringing their own experiences and perception with them. Quintessential to student success is that they exhibit good motivation and the ability to manage their cognitive processes at a higher level (Rogers & Freiberg, 1994; Brown, 1987). This management of higher level thinking skills, thoughts that governs thoughts, or metacognitive skills. As the students begin their educational quest, they are encouraged and challenged to use analytical skills in new ways. The use of preferred intelligence (Gardner, 1983) in learning environments can assist in engaging the student in the learning process.

Memory functions are depicted as continuously active: receiving, modifying, storing, and retrieving information (Baddeley, 1976, 1986; Klatzky, 1980). This foundational information assists in validating the presence of preferred intelligence. Along with theoretical considerations, this study will investigate the instructional potential for enhancement of metacognition (Baker & Brown, 1991) in problem solving situations and the use of multiple intelligence (MI) (Gardner, 1983).

According to Gardner (1983, 1993) intelligence is a set of physiologically differentiated productive capabilities used by individuals to find and solve problems. Also, problem solvers may need to engage in other levels of thought than currently emphasized in traditional educational systems: verbal, mathematical-logical, and spatial (Teele, 1996). Social interaction is found in cooperative groups and holds the potential for fostering development of metacognitive skills.

The institutional system has the power to encourage student development by being supportive. This study attempts to expand our understanding of the metacognitive skills and their relationship to student persistence. These higher thinking skills are directly transferable to potential work environments.

Need for the Study

Higher educational institutions exist to prepare students for the workforce. In the past two decades technology and automation have influenced work habits and life styles (Shneiderman, 2002). This has contributed to changes in the educational environment. As a result, occupations have encountered the impact of the automated revolution in the working environment. The primary goal of introducing automation is the expectation of enhanced safety, reduced data duplication and/or redundancy. The effect is to reduce the human workload. These benefits are based on the belief that overloading silicone-based systems cannot easily be accomplished. Due to the increased sophistication of advanced technology, the accentuated use of automation is appropriate for implementation in the work place. Thus, college graduates, by necessity, have become more technologically competent. As automation is introduced to the workplace, changing the work environment, there is less duplication and redundancy of task. Workers are often engaging in management and problem solving activities.

To best facilitate learning for the college student, researchers have extensively looked at the characteristics of the individual student to understand why success in the academic environment is not always achieved (Astin, 1971, 1975; Chickering, 1969, 1974; Cope & Hannah, 1975; Tinto, 1975). Research has been conducted relating to a student's individual characteristics and personal development. Astin, Korn, and Green (1987) stated that student retention and student satisfaction are viewed broadly as relating to institutional performance and student outcomes. The examination of this specific variable will provide a view of the learner's characteristics and development, psychosocial influence, and expectations (Astin, 1971, 1975; Bean 1980; Chickering, 1969; Cope & Hannah, 1975; Tinto, 1975). Understanding a student's reasons for academic difficulties is pivotal for the continued success of post-secondary institutions in the future.

The overall goal is to identify and establish if there are aids to assisting learners in the developmental use of metacognitive skills. Realizing that the task of examining the use of metacognitive skills in the educational system is an overwhelming endeavor and that systemic variables are often difficult to measure. This study will focus on analyzing a portion of the variables that attempt to define the learner's preferred intelligence. This creates a foundation for other areas of research that will need to examine the use of metacognitive skill.

Purpose of the Study

The purpose of any research investigation of this nature is to improve overall quality of life. In this case improvement of the learning environment is an issue. Understanding that the use of cognitive and metacognitive strategies holds the prospect for improving the efficiency and effectiveness for students. This research assists in unlocking the unlimited potential each individual possesses.

This study will assist in the development of conceptually driven patterns. All cognitive and metacognitive research findings can assist in developing intelligence measures and improving the quality of learning environments. The examination of multiple intelligence (MI) as it relates to student understanding of their own natural abilities has the potential to enhance metacognition.

Technology has changed the way the students are prepared for work. Therefore, research in the area of cognition/metacognition is needed. What separates the student from a computer system is the monitoring of thought processes and sensing that something is wrong. This sensing of maladies is an innate characteristic, heuristic cognition, simply stated thoughts governing the thought processes, metacognitive abilities. Metacognition is the skill that assists in the identification of maladies in the self-regulation of one's own thoughts. Proactive detection of problems with automated systems and analysis is the key to the success in academia as well as in life.

Extensive research has been conducted to examine the possible individual student characteristics that influence students in their educational pursuits (Anderson, 1985; Astin, 1975; Bank, Biddle, & Slavings, 1992; Beil & Shope, 1990; Cope & Hannah, 1975; Gold, 1995; Pascarefla, Terenzini, & Blimling, 1991; Porter, 1989; Tinto, 1975). Less is known about the student's preferred intelligence and use of metacognitive skills.

Statement of the Problem

The problem investigated in this study is: Does an explicit awareness of preferred intelligence in problem solving situations aid in the development of metacognition?

Research Questions

1. Does the learner's acknowledgment of preferred intelligence enhance metacognitive skills?
2. Does an explicit awareness of preferred intelligence influence their perception of others?
3. Are there meaningful materials such as pictures and other graphic forms that serve as intelligence factor?
4. How does the presence of preferred intelligence facilitate the use and enhancement of metacognitive skills?

In education, curriculum development, and learning environments, it has been suggested that these metacognitive skills should be incorporated in learning materials (Duell,1986). Society is now encouraging educators to maximize the learning experience by facilitating independent learning rather than the traditional role of an information giver (Teele, 1996; Rogers & Freiberg, 1994; Gardner, 1987; Bruner, 1973). It is possible that the predominant style of the learning environment inhibits rather than promotes metacognitive growth (Campbell, 1992).

There is an area of work in developmental psychology that emphasizes the need for metacognitive skills to support successful learning. Several cognitive instructional programs have been designed which aim to develop these executive control strategies (Teele, 1996; Garofalo & Lester, 1985; Lester, Jr., 1988).

There is a field of study that focuses on the development of expert skills based on metacognitive development showing that social interaction is vital to new learning, especially in role modeling situations, such as coaching and mentoring. This study intends to ascertain specific metacognitive skills involved in expert level decision-making and investigate the optimal learning environment for metacognitive skills enhancement.

Definition of Terms

Academic Success – Refers to the positive attainment of objectives made by a student.

Automaticity – As it relates to the information procession model is defined as a memory phenomenon typified by single process with direct access retrieval of solutions.

Controlled Processing – As it relates to the information procession model is defined as mental processing characterized by mentally demanding, prolonged response time, heavily dependent on working memory capabilities, and requires little or no practice to develop.

Generative – In the learning process is defined as problems are those that motivate open-ended inquiry, whose solutions require synthesis, which have multiple solutions, and which, therefore, promote the generation, evaluation and combination of ideas in the course of problem solving.

Intelligence – Is defined as "the ability to find and solve problems and create products of value in one's culture" (Campbell, 1992, p. 197).

Institutional Complexity/Diversity – The Carnegie Foundation for the Advancement of Teaching (1990) stated in their special report, *Campus Life: In Search of Community.*

Institutional Environment – A term used to describe an environment that includes many conditions and influences that affect the personal development and growth of the students (Kuh, et al, 1991). Campus environment has been broadly defined to include all the conditions and influences that could involve physical, chemical, biological, and social stimuli, that have been found to affect the growth and development of living things (Western Interstate Commission for Higher Education, 1972).

Metacognition – The ability to think about and manage thought patterns, regulating the knowledge about cognitive processing is an essential skill for learning to learn.

Multiple Intelligence (MI) – Is defined as the ability to resolve a problem or to create a product that is useful in society, and must also include the potential for finding or creating problems so that the groundwork is set for acquiring new knowledge.

Quality – Defined in a very broad sense is the acceptable level of performance within an organization. It is used in literature to refer to many areas including the product of an institution, the level of education that a student received, and the type of environment.

Student Persistence – This refers to student characteristic that are evident through the behavior of the individual. Often identified as "persisters," these students are those who continue through the academic process to acquire their set goals, that usually being graduation.

Supplantive – In the learning process is defined as information that is information supplied to the learner, such as data displayed on a screen and automatically updated requiring no learner interaction.

Assumptions and Limitations

1. It is assumed that the data collected in this study are accurate as applied to college age learners.
2. The study is limited to an adult population. The results cannot be generalized to other populations until additional studies are conducted.
3. The investigation is limited by the fact the students are self-reporting and may be bias by their perception.
4. This study is limited by the fact that the variables used to define the institutional environment are not inclusive of all components that work together to form the complex higher educational system.

Significance of the Study

This is an exploratory study using an adult population not previously studied. Information for examination by higher education instructors can be used in making decisions emphasizing instructional design and educational effectiveness. The main considerations were student persistence and motivation. From a cognitive perspective, this study examines and discusses the relationship between students and their dominant intelligence as defined by seven multiple intelligence factors (Gardner, 1993).

Peak performance depends on the experts developing a high level of skill for monitoring their performance. The changing technology and the increased workload generates the importance of this subject matter. As technological change is imposed on the educational environment, the need for expert decision making skills becomes more important. Conceivably automation could perform repetitive tasks allowing the employee to perform more creative and evaluative activities. As a result, automation of routine tasks might necessitate raising job requirements to accommodate increased complexity.

As previously mentioned, metacognition is the global term used to identify sets of higher thinking (thoughts that govern thoughts). Successful people are aware of their cognitive processes and consciously control them. Research conducted by Waterman and Peters (1982) site numerous examples of business executives using metacognitive goal setting strategies, monitoring, and cognitive reconstruction. Azzolino (1990) took the approach of addressing metacognitive skills explicitly by having students note their attitudinal levels of commitment and attention in journals. Students were required to write in journals stating how their cognitive awareness affects their behavior.

Improvements in the area of learning environment are critical from three positions: (1) the student will be able to reap the rewards that a college degree affords (2) the college or university will be able to maintain the income that derives from the student's attendance (3) society will be able to utilize the skills of students in becoming more productive (Tierney, 1992, p. 604).

Nora, Cabrera, Hagedorn, and Pascarefla (1996) observed that college student persistence has become one of the most important criteria upon which success in a higher education institution is rated. Institutions are being judged based on "learning productivity, retention, and graduation rates" (Schroeder & Hurst, 1996, p. 177). Even though other measures were considered for this study, the *Teal Inventory of Multiple Intelligence (TIMI)* is used as an expeditious means to determine the natural ability that university student's bring to the learning environment.

Enriching the student's environment is pivotal for the continued success of post-secondary institutions in the future. Much of the current literature focuses on the attributes of the individual student when examining retention and attrition rates. However, some investigation have been conducted to encompass a broader perspective in the examination of the student's academic persistence (Benjamin & Hollings, 1995). Bean (1980) stated that "a student's leaving school is the joint responsibility of the school and the student" (p. 149). This study will continue an ongoing examination of the adult college students and their environmental systems that significantly affect personal and academic development.

Organization of the Study

Chapter I is an introduction to the theory of multiple intelligence and metacognition. This chapter proposes the need for the study, the purpose of the study, the statement of the problem, definitions of terms, assumptions, limitations, the significance of this study, and the research questions.

Since the premise for this research is that young children have innate abilities to manage their learning, a look at memory function, the theory of Multiple Intelligence (Gardner, 1987) and, metacognition (Baker & Brown, 1984a & 1984b), follows in Chapter II. Chapter II provides an overview of the literature surrounding the areas of cognitive processing, multiple intelligence, and student motivation in instructional design. These reviews examine the stages of introspective multistage learning and document the need for metacognitive skills in trouble-shooting and problem-solving employment roles. Chapter III presents the sample, data sources, and research design for this study. Chapter IV discusses the analysis of the collected data. Chapter V will consist of summary, conclusions, and recommendations.

CHAPTER II

REVIEW OF LITERATURE

Successfully navigating life's trials often involves the use of cognitive processes. The thoughts that govern these cognitive strategies are called metacognition. In 1987 Brown discussed theoretical issues surrounding the study of metacognition; learner's verbal statements used as a form of data collection resulting in the use of abstractive reflection. Abstractive reflection is discussed in further detail later in this review.

Introduction

Metacognitive strategy construction is fundamental in problem solving situations. Bruner (1990) establishes the essences of cognition as making meaningful use of the abilities of the introspective mind. One component of metacognition is self-regulation. Self-regulation is the ability to conceptually reorganize. Flavell and Wellman, (1977) defined metacognition as the broad range of knowledge of each learner's unique cognitive functioning and regulation of cognitive activity, described as, "the feeling of knowing." Metacognition can be characterized as an individual's use of self-regulating strategies. Lester (1988) studied how learners take charge of their learning. He wrote, "I became convinced that training in the use of a collection of skills and heuristics without attention to affective and metacognitive aspects of problem solving is inadequate" (p. 117).

In order to understand the use of metacognition in the learning environment a look at the cognitive processing (information processing model) is necessary. The information processing model that has previously dominated theories of human cognition is the model of central processing. This model is a hierarchical structure of complex systems of thought processing. Often this system is addressed as long term and short-term memory. Long-term memory is accessed to analyze current situations against historical information.

Managing Cognitive Structures

Working (short-term) memory is where all cognitive operations obtain their information and construct outputs in response to stimuli. Working memory is generally defined as short-term memory functions, responsible for managing ongoing, transient information. Alternative hypotheses are generated and this process is convoluted by bias, working memory limitations and constraints (Wickens & Flach, 1988).

Understanding these two broad general categories of cognitive processing, long term and short term (working) memory, is fundamental to understanding the theory of cognition. The theory of working memory is well documented. Specifically, Braddeley (1980) states that a working memory system has executive control responsible for directing and coordinating information. In this theory, working memory consists of two subsystems: (1) the articulate loop and (2) visual-spatial scratch pad. These two systems are responsible for processing verbal and nonverbal information. Klapp and Netick

(1988) examined multitask performance in working memory and their results identify at least two working memory systems (that is, auditory-verbal and visual-spatial). Executive control (metacognition) is the ability to consciously plan and control the thinking strategies. The term executive control comes from the information processing body of research.

Occurring in this system of working memory are two types of processing: automatic and controlled. Automatic processing rarely demands strategic effort and is common to all age groups. With automatic processing the learner does not have to think about the next response to reconcile a problematic situation. Logan (1988b) established the theory of automaticity as a memory phenomenon typified by a single process with direct access retrieval of solutions.

Working memory stores action items in motoric codes. Motoric codes are motor and sensory representations of action events. The encoding of these involves past, present, and future events (Koriat, Ben-Zur, & Nussbaum, 1990). It is important for the management and other problem solving professions to recall past events to support ongoing tactical operations. Prospective memory is used for the to-be-performed activities (Harris, 1984 ; Winograd, 1988). This prospective memory can assist in the visualization of tasks that support encoding (Koriat, Ben-Zur, & Nussbaum, 1990).

Then further defining working memory research as static and dynamic. This research will now investigate dynamic memory. Dynamic memory was studied by Moray (1981, 1986) as an individual's ability to track and manage complex multidimensional information with no well-defined recall intervals. In comparison to static memory research, the sources are scarce.

Semantic codes are responsible for maintaining information in working memory. These codes are associated with conceptual meaning, not physical attributes. Semantics coding functions as a part of the organization and storage phase of working memory, subsequently residing in long term memory. Klatzky (1980) states that elaboration rehearsal, using semantic encoding in working memory, requires thinking about information (metacognition) and relating the input to other information in long term memory for future planning. Semantic codes are continually retaining and analyzing data to generate strategies for problem resolution. Controlled processing is mentally demanding. The response time for controlled processing is prolonged dependent on working memory capabilities. Controlled processing requires little or no practice to develop (Stien & Garland, 1993). In comparison, controlled processing is relatively slow and limited by the constraints of working (short-term) memory.

Short-term (working memory) is volatile and could be the strongest contributor to errors in problem solving situations. Documentation supporting the transient nature of working memory dates back to the 1950s. This initial series of research demonstrates the absence of sustained attention, approximately 15 seconds (Brown, 1958). Research has substantiated these findings in numerous other studies.

This information loss has a negative impact on memory and can be attributed to concurrent events and distractions demanding attention. Klapp (1987) concluded that if rehearsal occurs immediately following the reception of information, the information loss is less profound. Even though these terms relate to different processes, they share common elements in the ability to combine two or more elements into one.

Goetz (1984) believed that within 20-30 years, the cognitive-information-processing view of learning has emerged and learning is seen as a complex product of interrelated cognitive operations. The information processing model refers to cognitive overload and the strain it places on working (short term) memory (Phye & Andre, 1986). The theory of cognitive load is based on the limitations of working memory (Fleming & Levie, 1978; Miller, 1956). Individuals are accessing increasingly large amounts (clusters) of information in frequent need of revision. This vast input of clusters is the set up for information overload, increasing the need for efficiency in implementation of strategies while examining large amounts of data for storage (Charp, 1986; White, 1988).

Other research (Baker, 1963; Kvalseth, 1978; Mackworth, 1959; Moray, 1980; Yntema, 1963; Zeitlin & Finkleman, Rouse, 1973a, 1973b; 1975) seems to agree that dynamic memory capacity is much less than static, holding a maximum of three items. Yntema (1963) had three warnings about the reduction of dynamic memory and its limits, they are: (1) in monitoring situations the number of items that have varied should be limited, (2) the amount of information collected about each attribute did not degrade the dynamic memory, and (3) if the attribute value has its own scale, this makes the attribute unique, making the information easier to track. The data in Klapp and Netick's (1988) study suggests that to optimize working memory, tasks and subtasks must be allocated across subsystems.

Another well-documented method of managing cognitive structures is chunking (Miller, 1956). The terms organization and chunking are similar. However, chunking refers to current encoding of information to working memory, whereas the term organization in general is associated with long-term memory storage, and recall.

Functional elements for chunking must be context dependent. Chase and Simons (1973a, 1973b) defined the storage of labels for chunks of information in working memory. The labels they defined were tagged to the entire coded chunks of information. This is called perpetual chunking. Garland and Barry (1990a, 1991) hypothesized conceptual chunking, noting that skilled operators rapidly identified concept(s) of entire display screens of information. Then in the process of conceptual memory information is systematically retrieve functional units of conceptual information.

Wickens (1984) defines two essential processes benefitting from chunking; (1) assisting in the retention and maintenance of working memory, after which (2) the information is stored or dumped. Egan and Schwartz (1979) critiqued this chunking theory, pointing out that (1) no global processing occurs with chunked information and (2) a group of display features may not form a meaningful functional element or chunk. The conclusion is that the nature of working memory includes resources, conceptual information, task parameters, meaningfulness in context, skill, and expertise of the individual (Stien & Garland, 1993). Mental models can be global, including an entire task domain or specific to a given situation.

Multi-Component Memory Structures

There is a theory of multi-component working memory in which memory capacity is not limited to static memory functions. Multiple systems governing working memory that have been identified and are documented suggest numerous dual-task analysis situations (Navon & Gopher, 1979; Wickens, Sandry, & Vidulick, 1983). In these studies individuals perform two or more tasks simultaneously. Baddeley (1976, 1981, 1986) defines working memory as a product of multiple memory systems allowing skilled tasks to far exceed the three elements of dynamic memory limitation. Chase (1986) substantiated this theory, stating that experts in their area of expertise exceed the limitation of three elements of dynamic memory. Chase attributes this to the expert having access to vast amounts of domain-specific, long term memory knowledge foundational information serving two functions: (1) patterns can be used to identify similar situations and (2) conceptual knowledge is used to organize new information. According to Mogford (1991), they may or may not include goals, sub-goals, objectives, and operating guidelines. Some of the information must be remembered for a time, but once used, it is not needed and becomes unwanted baggage. Therefore, more information on how memories are coded into working memory as it relates to forgetting is necessary.

Piaget describes three types of self-regulation: autonomous, active, and conscious. Piaget defines autonomous self-regulation as unconscious adjustments and fine-tuning to motor actions. Testing theories in action by means of concrete trial and error leads to active regulation. Conscious regulation comprises the last category, earmarked by the ability to step back and consider one's own thoughts as an object of thought, weighing the consequences and ramifications of action alternatives taken. Piaget distinguishes between active and conscious regulation as, conscious regulation is a part of any knowing act. Reflective abstraction is the cornerstone guiding conscious regulation of the mental process and formal operational thought.

Metacognitive skills training has the potential for creating a learning environment where the accountability for education is shared, the learner is accountable for controlling their learning and the instructor is responsible for guiding, supporting, and facilitating the learning process. Generative problems are those that motivate open-ended inquiry, whose solutions require synthesis, which have multiple solutions, and therefore, promote the generation, evaluation and combination of ideas in the course of problem solving. Generative information is constructed as a result of an action that a person takes engaging them in the learning. Conversely a supplantive learning experience is information that is supplied, such as data displayed on a screen and automatically updated with no requirement for user intervention. Problem solving enhances learning. Design, by it's very nature, is a generative activity. Learning is more effective when generative problem solving activities are implemented (for example; identifying and formulating the problem, generating alternatives, evaluating, decision making, reflecting, and articulating). Therefore, design-oriented problems are particularly effective for technical domains like engineering, ATCS, and architecture.

There is an area of work that states generative information has better memory resilience. Too often, instruction provides learners is treated compartmentally with many bits of specific subject matter knowledge relayed to the learner. Without a holistic view many learners are never able to assemble and apply this knowledge in productive ways, particularly in real-world situations. One reason for this is the focus of traditional compartmentalized learning that isolates facts in disciplines. Theories of constructivism and situated cognition suggests that for learning to be useful the learner needs to be actively involved in constructing new knowledge within meaningful contexts, not merely absorbing it. Furthermore, group-oriented collaborative work, reflection, and articulation enhances learning. These are central premises of a multidisciplinary approach when structuring learning environments.

There is potential for training to enhance automatic processing for complex tasks (Hirst, Spelke, Reaves, Caharack, & Neisser, 1980). It should be noted that Fisk, Ackerman, and Schneider (1987) challenged those findings on the grounds that there was need for clarification between simple and complex tasks. To further confound this theory, simple tasks can be either automatic or controlled. Fisk, et al. (1987) theorized that if a task is consistent, then the determinant feature leading to automation of the task is practice.

Expert memory functions (metacognition) are more conceptual in nature. Expert memory is characterized by using the following process (1) identifying a concept for an entire stimulus of information, (2) using the information and testing the process related to problem resolution, then retrieval from storage is accessed in conceptually based chunks of information, and (3) verifying the information based on activated conceptual categories. Chase and Simons (1973a, 1973b) studied the expert skill level (metacognition) involving chess players. They found that these experts were able to encode more information, retain, and use it, than nonexperts. Then subsequently retrieve this information in meaningful units, as necessary.

Looking at other elements of the learning environment that enhance learning, Allen's (1991) research reported that all children show positive academic effects from homogeneous grouping. The greatest benefit noted from homogeneous grouping was received when learners observed that other learners with similar skill levels gradually improve over a period of time. In contrast less benefit was noted when the student observed a learner demonstrate perfect performance at the onset. Feuerstien (1978) states that cognitive growth is heavily dependent on the quality of mediated learning that children experience. By interacting with adults and peers who guide the child through problem solving activities, the child gradually begins to adopt regulating activities. Schoenfeld (1987b) questions the following learning experiences of students:

1. How accurate are students in describing their thinking?
2. How well do students track what they are doing when (for example) students are solving problems?
3. And how well (if at all) do they use the input from those problem-solving actions?
4. What ideas about prior experience in content do students bring to their work and how does this shape the way they do mathematics?(pp. 189-190)

Schoenfeld suggests that teachers/trainers model how to think through a given set of circumstances. When the teacher/trainer becomes a metacognitvely aware problem solver, he or she models the process by thinking out loud. Specific metacognitive processes that teachers/trainers model and learners need to practice are; self-planning, self-monitoring, self-regulation, self-questioning, self-reflection, and self-evaluation. Neither conceptual nor empirical integration of these two concepts has been reached subsequently metacognitive study split into the study of self-regulation and mind-theory (Brown, 1994, Wertsch, 1994).

The human instinct that detects problems is heuristic and can be attributed to the use of metacognitive strategies. Vygosky's theory of metacognition speaks of, "mastering one's own mental processes." Development of metacognitive skills is conceived, according to Vygosky, is not due to maturation or learning, instead a unique interplay of natural and cultural (intapersonal experience) processes. Lester (1988) studied how learners take charge of their learning. He wrote, "I became convinced that training in the use of a collection of skills and heuristics without attention to affective and metacognitive aspects of problem solving is inadequate"(p. 117).

Metacognitive skills training has the potential for creating a learning environment. The accountability for education is shared. The learner is responsible for controlling their learning and the instructor is responsible for guiding, supporting, and facilitating the learning process. Metacognition is a sophisticated mechanism for workload management.

Expert Strategies (metacognition) comprise three high-level aspects: monitoring, planning, and workload management. Endsley (1988) has defined these as "the perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future" (p. 1).

Understanding interrelated theory of the cognitive functions demonstrates the connections between concept elaboration, question specification, and explanation-strategy construction in a multistrategy framework (Birnbaum, 1986; Wilensky, 1983). Learning is characterized by three cognitive transformations occurring in effective learning from a performance failure in an intelligent system:

1. failure explanation,
2. learning goal specification,
3. learning-strategy construction.

Effective explaining procedures occur in three phases:

1. concept elaboration,
2. question specification,

3. explanation-strategy construction.

In both learning and problem solving, the reflective thinker is more effective when using metacognitive knowledge. Effective learners must be able to reason about their own reasoning failures. Effective problem solvers must be able to adequately monitor their own understanding and comprehension. Metacognitive strategies are used in both problems resolution and reasoning process.

Cognitive structures and decision-making strategies are not observable, thus it becomes necessary to identify methods and techniques that assist in producing reliable and valid behavioral data. Cognitive structures describe the organization and content of knowledge used by problem solvers. Presented is a multistrategy framework whereby various reasoning methods can be applied to cognitive tasks. Synthesis of ideas in learning and problem solving situations come from the educational disciplines, cognitive psychology, and artificial intelligence.

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1. Collaborative work is central to learning. Group-oriented work is important both in facilitating learning and in preparing students for today's multidisciplinary team-oriented workplaces. Learners are expected to

solve problems and do assignments in groups. Communication skills of students working in collaborative groups improve through articulation and reflection (Brown & Palincsar, 1989). This fosters an appreciation for the importance of distributed cognition as well as enhancing learning and subsequent transfer. Collaboration allows students to successfully tackle problems more complex than what any one group member could do alone (Pea, 1994).

2. Providing students with access to information about their dominant multiple intelligence that contain information-rich and contextualized descriptions of specific situations set within the broader context of a course can significantly impact learning and transfer. The availability and use of multiple intelligence during problem solving facilitates learning new knowledge, and supports the adaptation and transfer of previous solutions to the current problem (Kolodner, 1993).

It is expected that by revisiting design skills and applying the information about multiple intelligence, flexible transfer of these skills will be supported (Spiro, Coulson, Feltovich, & Anderson, 1988).

3. Learning and the acquisition of problem-solving skills need to be scaffolded. The experiences of implementing effective problem-based learning environments teach us that solving real-world problems requires scaffolding, that is, help from facilitators, knowledgeable experts, and the learning environment (Scardamalia, Bereiter, McLean, Swallow, & Woodruff, 1989).

The goals of scaffolding are to enable students to carry out a reasoning process or achieve a goal that they would not be able to do without help. The scaffolding of different skills can be provided through software, by appropriately utilizing multimedia and tools such as collaboration software, simulation and visualization programs, decision-support systems and smart case-libraries.

A shared electronic workspace that seamlessly integrates a full variety of functionalities for the above will enhance learning. This workspace will tie together tools that students will use while solving problems, collaborating, and acknowledging the student's multiple intelligence. It is also an ideal vehicle for providing adaptive scaffolding of various skills. Finally, it will encourage both synchronous and asynchronous collaborative work among students. Such an integrated yet flexible learning environment that the student can use as a "professional workspace" is a central component of our approach.

Situating information-rich contexts that afford opportunities for problem formulation, exploration and discovery are critical to success in learning and then future application. Learners will work on problems for extended periods of time, reflecting and articulating on both the process and the product. The problem students have to solve and the cases that are made available to them serve as anchors for learning.

Collaborative, reflective and articulate activities aided by the tools and objectives provided by the learning environment, should improve the students' knowledge, problem solving skills, and self-directed learning skills. This environment being a rich knowledge structure that explicate both conceptual and strategic knowledge, will allow the students to master concepts, principles and strategies in the course of attempting to solve problems. The collaborative nature of learner activities should facilitate the construction of new knowledge since it encourages articulation and intra-group communication.

Two important aspects of this approach are articulation and reflection. There are several forms of reflective articulation including generating analogies, predicting outcomes of events or processes (White, 1984), developing questions about the learning materials, and self-explanations (King, 1992). Studies suggest that reflective articulation can enhance retention, elucidate the coherence of current understanding of the problem being solved.

Now focusing on the development learner's self-directed learning skills, providing a mechanism for analysis of abstract knowledge to be processed from the content, thus facilitating transfer. It is very important to provide two levels of articulation, individual and group, in a collaborative learning environment. Also, it is not just articulation by itself that is important, but it is the specific kinds of articulations that engender reflection and reflective articulations, that lead to enhanced understanding. The goal of reflection is to analyze and evaluate one's knowledge, learning, and problem solving strategies. Several researchers have demonstrated the importance of articulation and reflection in learning. Pirolli and Recker (1994) suggest that reflection on problem solutions that focuses on understanding the abstract relationships between problems is related to improved learning. Lin (1994) has found that reflection on problem-solving processes lead to enhanced transfer and that technology can be used to scaffold appropriate kinds of reflections. One way that reflection can be enhanced is through the articulation of meta-cognitive knowledge and skills that typically occurs in collaborative discourse.

Believing that by having students analyze and apply multiple intelligence and by having them grouped in a manner that affords each group a well-rounded homogeneous set of talents. The cognitive flexibility theory (Spiro, Coulson, Feltovich, & Anderson, 1988) supports this prediction. Collaboration is a key piece of our approach. Research on collaborative learning shows that learning while solving problems in groups facilitates the learning of articulation skills, makes learning more effective for all group members, and allows students to successfully tackle problems more complex than any one group member could individually solve. Moreover, the collaborative discussion that occurs is important for student learning because it activates prior knowledge, thus facilitating the processing of new information (Schmidt, DeGrave, DeVolder, Moust, & Patel, 1989).

Conversely, Blumenfeld, et al., (1991) suggest that students may have more motivation to learn but make less use of learning and metacognitive strategies. In addition, students may not have the skills to benefit from collaborative work. Therefore, it is important to help students to collaborate well together in order to make collaborative learning efforts more productive for the learner. Aspects of this approach include the division of the student body into small groups, the complexity of the design problem each group will tackle, and the use of collaboration methods to scaffold communication and cooperative work are all intended to overcome these limitations and enhance the student benefits.

The information gained from the literature review assisted in defining and evaluating cognitive structures and metacognitive abilities that promote cognitive development leading to expert skill level. Metacognitive strategy construction is fundamental in problem resolution. Then a look at multiple intelligence (MI).

The precursor to collecting this data was measuring, defining, and understanding intelligence. Who is intelligent, how to become smarter, and what difference IQ makes are at issue. The research identified and analyzed the preferred intelligence of learners. Instructors will assist learners in determining their dominant intelligence. Examples of modifying the learning environments will be proposed to the instructors. By allowing the learners to monitor their own progress in instruction though journal writing to stimulate the use of metacognitive skills, the learner's motivation was enhanced and metacognitive growth fostered. Future research will focus on allowing the learners to demonstrate their understanding of acquired objectives by using their preferred intelligence.

Howard Gardner is Professor of Education and the author of many books including *Frames of Mind*, *Multiple Intelligences*, and *Creating Minds*. In 1981 he won a MacArthur Prize Fellowship and in 1990 became the first American to win the University of Louisville Grawemeyer Award in Education. In 1997 Gardener stated, "there are individuals-sometimes fabled-who were indifferent students (Winston Churchill and Thomas A. Edison) who certainly aced Life 101" (p. 10). Bright, new minds are formed every day, yet standardized test are not always accurate assessing who they are and if they will be success. Dr. Gardner believes that Americans have utilized standardized testing to an overzealous extent. High scores on standardized tests measure how well a student can take the test–not actual working knowledge.

Research defines intelligence as "the ability to find and solve problems and create products of value in one's culture" (Campbell, 1992, p. 197). The Multiple Intelligence is defined as the ability to resolve a problem or to create a product that is useful in society, and must also include the potential for finding or creating problems so that the groundwork is set for acquiring new knowledge. Looking at the assessment human intelligence in new ways is innovative.

The most prevalent form of educational assessment in the United States involves multiple choice or fill-in-the-blank questions that have been developed to assess the learners understanding of core competencies and objectives. When students receive information on a subject, they often feel overloaded with facts, statistics and other information to be assessed at a later date.

Gardner's (1995) theory of Multiple Intelligences has been grasped by the education community as a wonderful and meaningful way to account for the knowledge that "We are not all the same, we do not all have the same kinds of minds, and education works most effectively for most individuals if human differences are taken seriously" (p. 208). Whether it is a classroom environment or the world of business, each individual brings strengths to the situation. The ability to recognize and capitalize on individual strengths promotes innovation and creativity. We each bring a piece to the puzzle, a piece that adds color and beauty to the final product.

First MI theory and its application are discussed. Where did this idea of MI come from? Bruner identified three major classes of knowing: iconic, inactive, and symbolic (Bruner, 1967). Iconic was linked to the ways of knowing central to the visual and spatial arts. Inactive knowing framed the wisdom of movement, kinesthetic action, and dance. Symbolic represented the realm of reason and deductive logic (Samples, 1992). Bruner was not strongly supported at the time of this revelation, but Bateson (1979, 1987) later maintained that "aesthetics," in his view, offer a different dimension because it is the inherent expression of nature's plan.

So the question is not are these learners intelligent, but how do these learners best express their intelligence? Gardner, in *Frames of Mind*, replaces the standard view of intelligences with the idea that human beings have several distinct intelligence. Using an elaborate set of criteria–including evidence from studies of brain damage, prodigies, developmental patterns, cross-cultural comparisons, and various kinds of tests--Gardner identifies seven intelligences. Gardner reaches several conclusions about these "intelligences" (which he is willing to call intellectual competencies, thought processes, cognitive capacities, cognitive skills, forms of knowledge, or even useful fiction):

1. Human beings have and possess several distinct intelligences, not one general intelligence;
2. Each intelligence is relatively independent of the others;
3. Any significant achievement involves a blend of intelligence's; and
4. These intelligences are valued by cultures around the world, though not always valued to the same degree.

In Gardner's view, multiple intelligences "are present in virtually every realm of human activity" and not just in the verbal and analytical activities commonly called "intelligent" (p. 285). This conclusion elicits criticism from Gardner about the educational system's bias toward the linguistic and logical-mathematical intelligence–the two components of "IQ" as it is commonly understood.

MI theory is concerned primarily with cognitive operations. Gardner's theory is strong on intellectual operations and weaker in accounting for emotional, creative, and spiritual life. Gardner discusses how MI theory might relate such concepts as motivation, attention, persistence, learning strategies, learning styles, adaptability, practical intelligence, inspiration, and wisdom. His approach has potential for enrichment of the view of mind. At many points in *Frames of Mind*, writers would provide illustrations of Gardner's theories, but he does not mention them; he had other purposes in mind. Gardner has seven classifications for intelligence in this thinking theory called MI. The seven intelligences are: linguistic, logical-mathematical, spatial, body-kinesthetic, musical, interpersonal, and intrapersonal. Each person embodies the characteristics of most of these categories.

Understanding the premise of this MI is important because the Teele's MI Inventory was used to collect data in this research. This data collection tool is for use in the classroom and assists learners is knowing and being aware of these different intelligence. Individual differences may account for lacking metacognitive skills needed for trouble-shooting and problem-solving. This survey instrument is used to define preferred intelligence assisting in understanding individual differences. Teel (1992) originally developed this measurement tool, called *Teel Inventory of Multiple Intelligence (TIMI)* for elementary school children. Metacognition could be related to other social virtues, like creativity. Multiple Intelligence states that intelligence as defined by the scientific community review a range of positions and perspectives. Consider the concept of intelligence in different cultures and historical eras. Intelligence is perceived as a psychological and biological property of the individual.

Summary of Literature

The basic theoretical orientation for this study has been provided by the supportive literature in this chapter. A foundational understanding of various memory functions was addressed. Also, a discussion of managing cognitive structures was included.

Metacognitive skills training was discussed as having the potential for creating learning environments with a shared accountability for learning. One where the learner is responsible for controlling their learning and the instructor is responsible for guiding, supporting, and facilitating this process.

When using metacognitive strategies, in both learning and problem solving, the reflective thinker was found to be more effective. This research stated that effective learners are able to rationalize their own reasoning failures, understanding, and comprehension. The experiences of implementing effective problem-based learning environments also assist in the transference of learned information to the solving of real-world problems.

The research in this Literature Review reported positive academic effects from learners that were homogeneously grouped. Collaboration is a key element in the transference of articulation skills, making learning more effective for all group members, and allowing learners to successfully tackle problems more complex than any one group member could individually solve.

The information gained from the literature review assisted in defining and evaluating cognitive structures and metacognitive abilities that promote cognitive development for learners. In most educational systems measuring, defining, and understanding intelligence is done in a read the question and choose the most correct answer form. Who is intelligent, how to become smarter, and what difference capitalizing on the learner's strengths and/or weaknesses should be considered. A more realistic measure of intelligence should be at issue. Researchers, educators, and the business sector could look for the better ways to measure individual intelligence.

Gardner developed the theory of MI. The MI definition of intelligence is the ability to resolve a problem(s) and/or to create a product(s) that are perceived as useful in society, including the potential for finding or solving problems. This sets the groundwork then is set for acquiring new knowledge.

The ability to identify and capitalize on individual strengths and/or weaknesses promotes innovation and creativity. Gardner's question is not are learners intelligent, but how do these learners best express their intelligence? Gardner reaches several conclusions about intelligence(s). Gardner has seven classifications for intelligence. These seven intelligences are: linguistic, logical-mathematical, spatial, bodily-kinesthetic, musical, interpersonal, and intrapersonal. Each individual embodies the characteristics from most of these categories. This way of thinking about intelligence is easily adapted for classroom use, assists learners in knowing, being aware, and valuing difference in intelligence. Summating that understanding and expressing one's abilities through the use of preferred intelligence fosters metacognitive growth.

CHAPTER III

RESEARCH DESIGN

Earlier research, as pointed out in the previous chapter, has demonstrated that identification and application of metacognition is a legitimate area for continued investigation. Bruner (1990) pointed out that metacognitive development is fundamental in the problem solving process. This chapter outlines the research methods used in this investigation. This study focuses on students in the postsecondary environment and their understanding of their preferred intelligence as it relates to metacognitive skills. This study examined the relationship for learner understanding and use of preferred and secondary Multiple Intelligence (MI). There are four categories of MI defined for a learner's preferred intelligence. Understanding the innate characteristics of MI and implications for the growth of these learners in monitoring their learning suggested the need for classroom implementation. Metacognition includes thought processes that determine (1) what is known, (2) regulating when to ask for help and (3) how to learn to material.

Metacognition

An example of metacognition is a sense that something is wrong. Based on previous experience the student begins to use a question procedure to troubleshoot the perceived malady:

1. What current knowledge assists in this situation?
2. Is outside advice, expertise, and/or assistance available?
3. How much time is necessary to solve this?
4. What are some strategies and/or tactics available to assist in solving this problem?
5. Is my perception of the situation accurate?
6. What signals are there that an error is occurring?

Metacognition includes the ability to ask and answer these questions in the process of problem resolution. "Metacognitive deficiencies are the problem of the novice, regardless of age. Ignorance is not necessarily age related; rather it is more a function of inexperience in a new (and difficult) problem situation" (Brown, 1987, p. 475).

Metacognition consists of four basic phases:

1. Developing a plan of action
2. Implementing the action plan
3. Maintaining/monitoring the plan
4. Evaluating the plan

As we approach a problematic situation in the first phase of metacognitive analysis we begin to generate questions that assist in developing the plan of action. Examples are as follows:

1. What prior knowledge will help with this particular task?
2. What direction should cognitive strategies take?
3. How should this be prioritized?
4. Is time a constraint if this strategy is employed?

During the second and third phase of the use of metacognitive problem solution, called implementing and maintaining/monitoring the plan of action, we generate questions. Examples are as follows:

1. What information is important to remember?
2. What is the correct problem solving strategy to employ?
3. Should the pace be adjusted in contrast with level of difficulty?

In phase four the plan of action taken is evaluated and a questioning process occurs:

1. How well did this plan work?
2. Were the results predictable?
3. In what ways should this strategy be modified for future use?
4. Does the learning portion of this situation transfer to new situations?
5. Is there a sufficient level of understanding as to why this strategy worked?

Instrumentation

Data was obtained from four different college classes comprising 62 subjects. The *Teele Inventory of Multiple Intelligence (TIMI)* (Appendix A) was used to collect the data. This instrument is a forced choice pictorial inventory that contains 56 numbered pictures of panda bears representing the original seven MI defined on the TIMI. The instrument provides 28 opportunities for subjects to select between two choices obtained from the Teele Inventory of Multiple Intelligence.

The TIMI is based on the seven classifications of MI defined by Gardner. Each student was provided a TIMI Tally Sheet to record their response by selecting one of the two choices that best described their preference from 56 slides. They were also told that there are no right or wrong answers.

Upon completion of all 56 slides each student's answer sheet was easily scored. The results were coded with a number that represents one of the seven Multiple Intelligence areas. The facilitator used a key transparency and overhead projector to project information that assisted the students in recording and tallying their responses. Once each student coded their Tally Sheet (Appendix B), the data were tabulated and recorded in the four boxes at the bottom of the Tally Sheet. This process identified each student's (1) classification for a primary preferred MI placed in the first box of the four boxes, (2) secondary MI placed in the second box, (3) 3rd MI placed in the third box, and (4) 4th MI placed in the fourth and last box on the bottom of the TIMI Tally Sheet. A MI profile was developed for each student. This profile documented the percentage of each subject's (1) classification for (2) primary preferred MI, (3) secondary MI, (4) 3rd MI, and (5) 4th MI. A debriefing session was used for the facilitator to define each of the seven classifications of MI.

Subjects

The population for this study were students at a post-secondary institution granting associate degrees. Specifically the descriptors of environmental constraints that best described this audience were ages18 years and older. Each subject was given an Informed Consent form (Appendix C) which was to be completed and returned to the researcher prior to their participation in the study. A request to the Oklahoma State University Institutional Review Board (IRB) was made and permission was granted to the researcher to conduct the study (Appendix D).

The subjects were chosen from two different college departments. The subjects were selected from the Department of Arts and Humanities and Math Science. Each class surveyed was different with students enrolled in the following four areas:

1. Grammar and Writing
2. Humanities
3. College Algebra
4. Earth Science

The students were chosen from more than one college discipline for both daytime and evening classes.

If this study indicates a connection between the subject's understanding and use of MI and development of enhanced appreciation for differences in others (see research question 3), there is need for further studies in this area. There are also implications for further research supporting the premise that college environments do affect learner's behavior and can assist in the development of innate abilities, such as managing and monitoring their learning and making appropriate modifications when necessary. Learner attitude toward the MI theory is defined by use of informal assessment done during the debriefing that followed the data collection.

Procedures

The TIMI inventory requires 30 to 45 minutes to complete. The TIMI in print based form can be used as overhead transparencies on an overhead projector or scanned in digital format and compiled into a PowerPoint Presentation. Data for this study were acquired through the use of a PowerPoint Presentation compiled from print-based material called the TIMI.

The facilitator instructed students to print their name, the school name, the date, and circle AM or PM to designate the time their class meets on their Tally Sheet. Then the facilitator explained that for each set of two slides displayed, one should be chosen. As each slide set was displayed, the first slide in the set was labeled as slide A, and the second slide in the set was labeled slide B. The facilitator instructed the students to select only one slide in each set, for example the first set was numbered slide 1A or 1B, the second set was numbered slide 2A and 2B and so forth. In each set students chose either the A or B slide that best described them. As the PowerPoint slide sets were displayed the students choose either slide A or B and placed a checkmark on their Tally Sheet in the box under column A or B for each appropriate number for the slide set being displayed. This process was repeated choosing the best choice A or B that describes their preference to each of the 28 slide sets presented. Students were instructed to not put a check in both boxes for the same numbered slide set, only A or B. The students were also told that there were no right of wrong answers.

Upon completion of all 56 slides each student's Tally Sheet were scored. The facilitator displayed a key transparency using an overhead projector to assist the students in recording and tallying their responses. Each slide had a code representing one of the seven MI that this instrument was based on. For example slide set 1A and 1B would have a 1 (Linguistic) code if A was chosen or a 4 (Spatial) if B was chosen. Once each student coded their Tally Sheet, the 28 codes were tabulated. There are seven spaces to the left of Total on the Tally Sheet. All number 1 codes are counted and the Linguistic total is placed in the first space to the right of the word Total below the A and B columns on their Tally Sheet. Next all number 2 codes were counted and the Logical-Mathematical total were placed in the second space to the right of the Linguistics Total below the left A and B columns on the Tally Sheet. When all seven MI codes were recorded on the Total line beneath both left and right columns A and B the (1) primary preferred MI, (2) secondary MI, and the two lesser of the MI characteristics were defined. The primary preferred MI was defined by finding the largest number of all seven numbers on the Total line and just beneath the largest number is the name of that MI. Students then wrote the name of the MI represented by the largest number on the total line in the first of the four boxes, below the Total line at the bottom of the Tally Sheet. The name written in the first box defined the students (primary preferred MI). Then the student found the second largest number of all seven MI on the Total line and recorded the name of the second largest number on the Total line in the second of the four boxes below the Total line at the bottom of the Tally

Sheet. The MI written in second box defined the secondary MI. The students found the third largest number of all seven MI on the Total line record the MI name in the third of the four boxes below the Total line at the bottom of the Tally Sheet. The students found the fourth-largest number of all seven MI on the Total line and recorded the MI name in the last of the four boxes, below the Total line at the bottom of the Tally Sheet. The students developed their MI profile and an understanding of the seven MI classifications during the debriefing session that followed. During the debriefing session the students were given an in-depth explanation of each of the seven categories of MI. This was followed by questions the students asked the facilitator. The questions were a reflection of the combined understanding that the students gained from the TIMI Profile, the facilitator's explanation of the seven categories of MI, and other student questions.

CHAPTER IV

RESULTS

Introduction

The problem investigated in this study was: Does an explicit awareness of preferred intelligence in problem solving situations aid in the development of metacognition? Metacognition was defined in the previous chapter as thoughts used to manage one's thought processes. Multiple intelligence will be defined in this chapter.

This study used the theory of multiple intelligence (MI), (Gardner, 1987) to define intelligence. Gardner's question was not are learners intelligent, but how do these learners best express their intelligence? Gardner reaches several conclusions about intelligence(s), resulting in seven classifications for intelligence. These seven intelligences are listed in Table I.

Each individual embodies the characteristics from most of these categories. This way of thinking about intelligence is easily adapted for classroom use, assisting the learners in knowing, being aware, and valuing difference in intelligence. Understanding and expressing one's abilities through the use of preferred intelligence fosters metacognitive growth.

Table I

Defined Seven Multiple Intelligence (MI) Factors

Multiple Intelligence (MI) Ranking	Multiple Intelligence (MI) Name
1st	Linguistic
2nd	Logical-Math
3rd	Spatial
4th	Bodily-Kinesthetic
5th	Musical
6th	Interpersonal
7th	Intrapersonal

The purpose of this study was to examine the relationship between the identified dominant multiple intelligence (MI) to the students' other three secondary MI classifications. Also attitudinal differences among the subjects were observed and documented. Attitudinal differences were measured through questions and comments made by students during the debriefing that followed data collection. This study sought to begin to provide a foundation to integrate the student MI data, with an adult audience. Also, it identified specified student characteristics and to look at their relationship to the use of metacognition.

The student characteristics that were available for use in this study and chosen for consideration included: (1) the dominant MI and the secondary MI, (2) second MI; (3) third MI; (4) fourth MI; and (5) evening and daytime students. These variables suggested a specific view of learning capabilities that can lead to the development and use of metacognitive skills. Other data included the subjects surveyed were (1) daytime students and (2) evening students. These are illustrated in Table II.

Table II

Audience Variables Available

Preferred Multiple Intelligence	Dominant MI	Secondary MI	Third MI	Fourth MI
Other Data Collected	Daytime Students		Evening Students	

Research Questions

The research questions addressed in this study were:

1. Does the learner's acknowledgment of preferred intelligence enhance metacognitive skills?
2. Does an explicit awareness of preferred intelligence influence their perception of others?
3. Are there meaningful materials such as pictures and other graphic forms that serve as intelligence factor?

4. How does the presence of preferred intelligence facilitate the use and enhancement of metacognitive skills?

Discussion of Research Questions

The results presented in this chapter are the analyses that are related to the stated research question and the procedural analyses.

Research Question One

Does the Learner's Acknowledgment of Preferred Intelligence Enhance Metacognitive Skills?

Since the MI classifications are a quantitative variable, Question One was examined by looking at the seven intelligence factors (Gardner, 1987), calculating a mean for each MI. First, in Table III, a summary of the means was presented. Then, in Figure 1, a bar graph was used to provide an overall view of the means.

Table III

Summary of MI Means for College Freshman

Category	Means
Linguistic	2.55
Logical-Math	1.19
Intrapersonal	3.02
Spatial	4.97
Musical	3.37
Bodily-Kinesthetic	5.18
Interpersonal	6.05

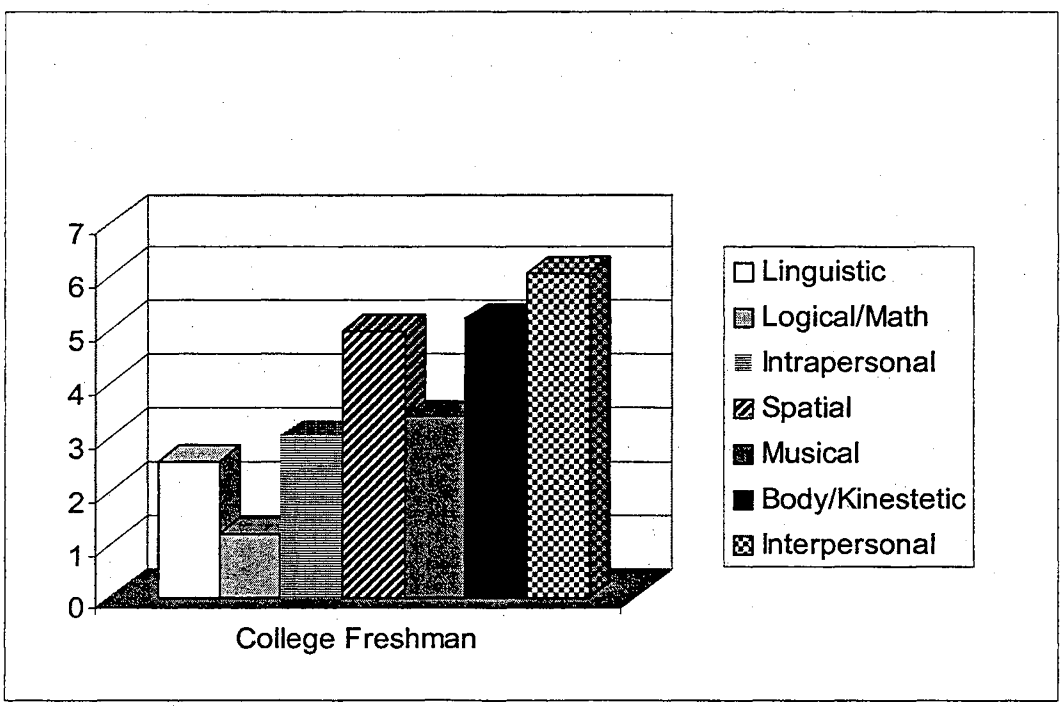

Figure 1. MI Measure of Natural Intelligence–College Freshman.

It is interesting to note that both linguistic and logical/mathematical are low averages. There was not enough information gathered on this group of adult students to answer this research question.

Research Question Two

Does an Explicit Awareness of Preferred Intelligence Influence Their Perception of Others?

During the four debriefing sessions, the following the facilitator's explanation of definitions for each of the seven MI intelligence factors, questions were asked by the students and/or comments were discussed. These are a sample of the nature of the questions student's asked:

1. What if my Dominate Preferred Intelligence and Secondary Preferred Intelligence are tied at Spatial and Body/Kinetic?

Facilitator Response: Consider the characteristics of Spatial and Body/Kinetic, now decide which of these describes you best. List the Dominate Intelligence that best describes you as Multiple Intelligence (MI) 1 and the other as MI 2.

2. What does it mean if my study partner and I have much different dominant intelligence profiles?

Facilitator Response: You and your study partner have varied talents and preferred intelligence factors. This can be a valuable tool for both of you. For in any given situation you may be able to see different sides of the same situation.

3. I'm messed up! What if my 3rd MI and 4th MI are Intrapersonal and Interpersonal?

Facilitator Response: You may be shifting from one Dominate Intelligence to another. This could be a sign that your perception or your socialization skills are changing.

4. So in this or other classes when we work in groups should the group members include all the same preferred intelligence?

Facilitator Response: That would depend of if you wanted your group work to be multifaceted or derived from a single point of view.

5. Do these MI stay the same always?

Facilitator Response: The key word is always–NO. Research among different primary and secondary school children suggests that Multiple Intelligence factors are dynamic, not static. The research on adults to answer this question is ongoing but not yet available. If you would like more information on this I will talk to you after class.

6. I was a football player for my middle and high school years, yet Body/Kinetic is my 3rd MI could this be wrong?

Facilitator Response: Your MI Profile could be wrong. I suspect that you may have enjoyed sports yet had academic interest as well.

7. What if my dominant MI is a much higher number than any of the others?

Facilitator Response: You may have focused on a MI factor that you particularly enjoyed. This would leave room for future growth in other areas. If you would like more information on this I will talk to you after class.

8. Do you know what MI is the highest percentage?

Facilitator Response: Research supports the Spatial MI as the most prevalent.

Due to the fact that students have a keen sense of humor not all comments were included. Only the student comments directly relating to MI factors have been documented. Some questions between classes were very similar and are represented by a single question.

Research Question Three

Are There Meaningful Materials Such as Pictures and Other Graphic Forms That Serve as Intelligence Factor?

The means for seven MI of College Freshman were displayed in Table III. The data collected was used to calculate the mean of the seven intelligence factors. These averages demonstrated that Interpersonal being the highest. This may indicate that as people get older their social skills improve. The implications for learning are that beyond the primary grades having students participate in small groups on projects is a realistic instructional strategy.

The second highest mean was a Body/Kinetic. This may hold true because organized sports are encouraged, often rewarded, from Junior High School until the Senior Year in College. Spatial MI was the third highest of the means for this adult population. This implies that visual aids are a useful tool in education. Then Musical MI ranked fourth MI highest of the. The ranking of Musical MI as the fourth of all seven intelligence factors could be attributed to increased social skills, music becoming an integral part of an individuals age and culture, etc.

Research Question Four

How Does the Presence of Preferred Intelligence Facilitate the Use and Enhancement of Metacognitive Skills?

As in Research Question One, in theory if students were allowed to demonstrate learning gains through the use of their MI Profile their ability to manage their own learning (metacognitive skills) would be enhanced. Due to the limited nature of this study it is recommended that further research be conducted concerning the relationship of MI and use of metacognitive skills. In the setting where learners are informed of their preferred MI the results could be used to document the application of metacognition. This process would ideally occur over an extended period of time with the initial group and be repeated with subsequent groups. There was not enough information gathered in this research to document this theory and/or answer this research question.

Summary

The Multiple Intelligence factors used in this study (dominant MI, second MI, third MI, fourth MI) suggested a specific profile of learning capabilities and natural intelligence. Two additional data items that were collected included students who attended daytime or evening classes. The time class was attended and showed little or no differences between groups.

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to examine, from a limited perspective, the relationship between the learner's understanding of preferred intelligence and metacognitive development. The primary question this study investigated was: does an explicit awareness of preferred Natural Intelligence in problem solving situations aid in the development of metacognition? The premise for this research was that students have innate abilities to manage their learning.

The evaluation of traditional educational systems needs to include support and enhancement of natural intelligence factors. As the students begin their educational quest, they are encouraged and challenged to use analytical skills in new ways. When the students are engaged in a learning process, change promotes the use of metacognitive skills. Therefore, these factors relate to the learner's development and enhancement of metacognitive skills. In educational and learning environments, it has been suggested that metacognitive skills should be incorporated into the learning process (Bruner, J.S.,1973).

One element that this research sought to examine was the management of higher level thinking skills, or metacognitive skills. The learning environment has the power to encourage student development by providing a supportive base. One contribution of the present effort sought to expand was the understanding of metacognitive skills.

Informing student's about natural intelligence factors empowers them to acknowledge their preferred intelligence. This assists them in understanding their academic strengths and weaknesses. If instruction encouraged learners to use their preferred intelligence, the learning environments would assist in the development and use of metacognitive skills.

The personal growth that students obtain from the educational process can benefit other areas of their lives. Through the use of metacognition optimal learning can be achieved. Students can work more efficiently using higher level thinking skills. These skills are also directly transferable to potential work environments, Insel and Moos, (1974) stated that, "the way one perceives his surroundings or environment influences the way one will behave in that environment"(p. 179).

Conclusions

The literature review assisted in providing a foundation of definitions necessary for this project and implications for improvements in the instructional environment. Specifically research Question One examined the learner's acknowledgement of preferred intelligence as it related to the enhancement metacognitive skills. Understanding of multiple intelligence (MI) and cognition assists in facilitating the use of metacognition. In a learner-centered environment the relationship of the knowledge of dominate multiple intelligence (MI) and learner understanding were examined. Students used the innate characteristics of MI to monitoring their use of metacognitive skills. Actually this represented an attempt to look at how the knowledge of dominant intelligence affects learning.

Metacognitive skills represent the management of a persons learning. Being aware of the characteristics defined by multiple intelligence (MI) can aid the learner by allowing them to define their preferred multiple intelligence (MI) factors. This can serve as an academic road map in many ways; knowledge that Spatial MI, as a dominant intelligence factor, can prompt the learner to explore opportunities for growth in area of Linguistic and Logical/mathematical intelligence factors.

The acknowledgement of multiple intelligence (MI) in the learning environment set up new forms of evaluation. The first step was to establish an environment and apply the principles of multiple intelligence (MI). When learners are able to demonstrate gains on specific classroom objectives they can also monitor their own learning.

The subjects understood the multiple intelligence (MI) principles and placed more value on objective based evaluation instruments. During the debriefing sessions questions surfaced suggesting that the students were interested in learning more about multiple intelligence (MI) factors. Therefore it assisted students in taking more responsibility for their learning. Due to the limited nature of this study additional research needs to be conducted concerning the relationship of multiple intelligence (MI) and use of metacognitive skills. This process would ideally occur over an extended period of time with the initial group and be repeated with subsequent groups.

Research question one explored the relationship of learner's acknowledgement of preferred intelligence enhance metacognitive skills. The population used in this study was not observed over a long enough period of time to answer this research question. It is recommended that further research be conducted where the population understands their preferred intelligence and documents their thought about learning over a minimum of one semester.

Research Question Two dealt with the diversity of learning styles. The conclusion was that learner's strengths are not exclusive to the dominant multiple intelligence (MI). The Teele Inventory of Multiple Intelligence used to collect data identified four preferred intelligence and enhancement of metacognitive skills. During the debriefing discussion a variation in attitudes were also noted. This created a greater appreciation for working together. The understanding emerged that one's own strengths may actually be another's deficit area. The understanding of cooperative learning produced a higher appreciation for diversity.

In this study the means for all seven multiple intelligence (MI) factors, displayed a pattern that Interpersonal multiple intelligence (MI) increased with the number of years in a formal educational system. This would imply that the longer students stay in an educational system they tend to work better in-group settings and value others. The Literature Review suggested that metacognitive skills are enhanced by peer-tutoring and work done in group settings. Both of these options should be implemented in the learning environment when appropriate.

The demonstration of learning gains, on specific objectives, should not exclusively limited to the use of the dominant multiple intelligence (MI). When students used the secondary multiple intelligence (MI) factors growth occurred in all defined preferred intelligence areas. These learning gains could demonstrate acquisition of new higher level thinking skills.

Question three dealt with the Spatial dominant intelligence factor. The finding indicate that the means for Spatial intelligence factor is predominately high for all subjects. This suggests that there is a significant population that derives meaning from materials such as pictures, flip charts, and other graphic forms. Evaluation of learning material at all levels should be conducted.

Research question four looked at the relationship between understanding the preferred intelligence factors and asked if this knowledge facilitated use and enhancement of metacognitive skills. As in research question one the population did not document their thoughts about learning and was not observed long enough to answer this question. A longer study where the learners are informed of their preferred intelligence factors and journal on their perception of the learning process is needed to adequately answer this question.

The current academic environment may not capitalize on innate learner intelligence. In the ongoing process of evaluating learning environments this study suggested implications for modifying the learning environment. Learning environments should be structured in a manner that capitalizes on the learners preferred intelligence in order to provide an optimal learning experience for all learners.

Recommendations

The primary question this study investigated was: does an explicit awareness of preferred natural intelligence in problem solving situations aid in the development of metacognition? There were three areas this study sought to investigate. Therefore the research recommendations are presented in the categories; multiple Intelligence, metacognition, and the application of multiple intelligence (MI) to enhance metacognition.

It is interesting to note that both linguistic and logical/mathematical are low averages, coinciding with increased time in formal education. Although the data collected for this research with adults follows a pattern previously documented (Teele, 1993), there was not enough information gathered about the learner's thoughts about their learning and a lengthier observation was needed. Therefore further research is suggested for further understanding and of multiple intelligence (MI) factors:

1.) A longitudinal study should be conducted about multiple intelligence (MI) factors. The present research included community college students. A replication of this study should be conducted at all levels of higher education. The population should also be diverse collecting data across various college disciplines. Documenting these research findings about the subjects understanding and application of intelligence factors.

2.) In the present study the subjects were younger than 36. A replication of this study with an older (over 45 years of age) population would provide an interesting comparison to this investigation.

3.) To survey a more diverse population the development and implementation of an Internet survey of multiple intelligence (MI) factors should be developed. This instrument would be used to surveying and inform these subjects of their preferred intelligence factors. The debriefing could be done as a chat room environment. Documentation would be used to capture information about the impact of understanding multiple intelligence (MI) factors had on these individuals.

4.) Taking the foundation of this study and applying it to bilingual students may result in predictable patterns of multiple intelligence (MI) factors. This could open the door for many comparative studies.

5.) Surveying and informing individuals from distinct ethnic backgrounds, informing them of the multiple intelligence (MI) factors, and documenting attitudinal differences should be done. Repeating this across different cultures. Documenting the results for use in other comparative studies.

Multiple Intelligence factors are one means of moving learners toward understanding management of their thought processes. Further examination about the way individuals manages their own thought processes are needed. To provide documentation about the enhancement metacognitive growth the recommendations are:

1. Use an evaluation instrument to contribute to instructors understanding of Multiple Intelligence factors. This could be developed as in-service for educators. In-service training of this type could promote a greater appreciation for diversity and movement toward the enhancement of metacognition.

2. A longitudinal study with the same subjects could provide information concerning their reasoning about thought processes. The instructor would need to model the use of metacognitive skills. Students would be required to journal about the thought processes used in managing their own learning. It is recommended that the classroom environment be structured using concise objective based assignments. All assignments would have a journal entry component where the learner reflects about their thought process management.

3. A nonacademic population, for example upper management, could be used to explore how problem solvers generate resolution in situations that contain element of spontaneous combustion. Due to the nature of their jobs an Internet survey could be used for data collection.

4. A group learning environment, that is computer based, could be set up with chat rooms for students to discuss their understanding of the learning objectives. The feedback gained from other students could assist the learner in monitoring their understanding, management of thought processes, and assist in building confidence through peer tutoring. A component of the instruction would be that the learners document their interaction and how it affected their learning.

To determine whether or not knowledge of multiple intelligence (MI) factors aid in the development of metacognitive skills more information is needed. It is recommended that:

1. A longitudinal study is done in a classroom setting where this study is repeated preferably by a facilitator other than the instructor. The instructor would be cognizant of higher thinking skills. The instructor would model the use of metacognitive skills. It is recommended that the classroom environment be structured in a manner that informs students of multiple intelligence (MI) and evaluates learning gains using a specific multiple intelligence factor. The course

work should also be structured to allow work in small groups when appropriate. The students would document information concerning reasoning about thought processes. Each student using a self-report journal entry system about the thought processes governing the management of their learning. All assignments would have a journal entry component. This should be replicated over four or more semesters.

2. Another method of acknowledging multiple intelligence (MI) factors would be to allow the students to demonstrate learning gain in their preferred intelligence. A word of caution, the objectives should be clear and concise and it is best if a rubric is developed for the instructor to grade. All assignments would mirror the evaluation objectives. As the learners work through each unit there would be a journal entry component. This journal entry component would consist of the students thought reflection about there learning. The initial study could be analyzed to determine if the learner's journaling indicated growth in managing their learning near the end semester. This should be replicated over several semesters the data could be used in a comparative analysis.

The opportunities for assisting learners in achieving academic success are limitless. As an ongoing effort educators should be open the change and seek to enhance the learning environment.

BIBLIOGRAPHY

Allen, S. D. (1991). Ability-grouping research reviews: What do they say about grouping and the gifted? *Educational Leadership Research, 72,* pp. 63-67

Anderson, E. C. (1985). Forces influencing student persistence and achievement. In L. Noel R. Levitz (Eds.). *Increasing Student Retention.* San Francisco, CA: Jossey-Bass.

Andre, T., & Phye, G. D. (1986). "Cognition, learning, and education," in *Cognitive Classroom Learning.* G. D. Phye and T. Andre, (Eds.). New York, NY: Academic Press, pp. 1-19.

Austin, A. W. (1971). *Prediction academic performance in college.* New York, NY: Free Press.

Austin, A. W. (1975). *Prevent students from dropping out.* San Francisco, CA: Jossey-Bass.

Austin A., Corn W., & Green, K. (1987). Retaining and satisfying students. *Educational Record, 68,* pp. 36-42.

Azzolino, A. (1990). Writing as a tool for teaching mathematics: The silent revolution. In T. J. Cooney (Ed.) *Teaching and Learning Mathematics in the 1990s* (pp. 92-97). Reston, VA: National Council for Teachers in Mathematics.

Baddeley, A. D. (1976). *The psychology of memory.* New York, NY: Basic Books.

Baddeley, A. D. (1981). The concept of working of memory: A view of its current state and probable future development. *Cognition, 10,* pp. 17-23.

Baddeley, A. D. (1986). *Working memory.* Oxford: Clarendon Press.

Baker, C. (1963). Further toward a theory of vigilance. In D. Buckner & J. McGrath (Eds.). *Vigilance: A Symposium.* New York, NY: McGraw-Hill.

Baker, B., & Brown, B. (1984a, 1984b) Construct meaning. (Palincsar & Brown, 1984a, 1984b, 1986) Paris, Wasik, & Turner, 1991.

Bank, B. J., Biddle, B. J., & Slavings, R. L. (1992). What do students want? Expectations and undergraduate persistence. *The Sociological Quarterly, 33,* pp. 321-325.

Bateson F. M. (1987-1990). Circ. Roy. Astron. Soc. New Zealand.

Beil, C., & Shope, J. H. (1990). No exit: Predicting student persistence. AIR 1990 Annual Forum Paper. (ED321669).

Bean, J. P. (1980). Dropouts and turnover. The synthesis and test of a casual model of student attrition. *Research in Higher Education, 12,* pp. 155-187

Bean, J. P., & Bradley, R .K. (1984). Untangling the satisfaction-performance relationship of college students. *Journal of Higher Education, 57*, pp. 393-412

Benjamin, M., & Hollings, A. E. (1995). Toward theory of student satisfaction: An exploratory study of the quality of student life. *Journal of Student Development, 36,* pp. 574-586.

Blumenfeld, P., Soloway, E., Marx, R., Krajcik, J., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational Psychologist, 26*, pp. 369-398.

Brown, A. (1978). Knowing when, where and how to remember: A problem of metacognition. In R. Glaser (Ed.), *Advances in Instructional Psychology*. Hillsdale, NJ: Erlbaum.

Brown, A. (1987). Metacognition, executive control, self regulation, and other more mysterious mechanisms. In F. Wienert & J. Kluwe (Eds.), *Metacognition, motivation, and understanding* (pp. 65-116). Hillsdale, NJ: Erlbaum.

Brown, J. (1958). Some tests of the decay theory of immediate memory. *Quarterly Journal of Experimental Psychology, 10,* pp. 12-21.

Bruner, J. S. (1990). *Acts of meaning.* Princeton, NJ: Harvard University Press.

Bruner, J. S. (1973). *Going beyond the information given*. New York, NY: Norton.

Bruner, J. S. (1967). *Studies in cognitive growth.* New York, NY: Wiley & Sons.

Campbell, B. (1992). Multiple intelligence in action. *Childhood Education, 68(4)* pp. 197-201.

Chase, W. G., & Simon, H. A. (1973a). The minds eye in chess. W. G. Chase (Ed.). *Visual information processing (p. 215-272).* New York, NY: Academic Press.

Chase, W. G., & Simon, H. A. (1973b). Perception in chess. *Cognitive Psychology(4),* pp. 55-81.

Chickering, A. W. (1969). *Education and identity*: San Francisco, CA: Jossey-Bass.

Chickering, A. W. (1974). *Commuting vs resident students*. San Francisco, CA: Jossey-Bass.

Cope, R. G., & Hannah, W. (1975). *Revolving college doors: The causes and consequences of dropping out, stopping out, and transferring.* New York, NY: Wiley & Sons.

Dey, E. L., & Hurtado, S. (1995). College impact, student impact: A reconsideration of the role of students within American higher education. *Higher Education, 30,* pp. 207-223.

Duell, O. K. (1986). Metacognitive skills. In G. Phye & T. Andre (Eds.), *Cognitive Classroom Learning*. Orlando, FL: Academic Press.

Egan, D. E., & Schwartz, B. J. (1979). Chunking in recall of symbolic drawings. *Memory & Cognition, 7,* pp. 149-158.

Endsley, M. (1988a). Design and evaluation for situational awareness enhancement. In *Proceedings of the Human Factors Society 32rd Annual Meeting,* 1, 97-101. Santa Monica, CA: Human Factors Society.

Endsley, M. (1988b), Situational awareness global assessment technique (SAGAT). In *Proceedings in the IEEE 1988 National Aerospace and Electronics Conference – NAECON,* 1988 , 3, 789-795. New York, NY: New York Institute of Electronical and Electronic Engineers.

Fisk, A. D., Ackerman, P. L., & Schneider, W. (1987). Automatic and controlled processing theory and its applications to human factors problems, In P. A. Hancock (Ed.), *Human Factors Psychology* (p.159-197). New York, NY: North Holland.

Flavell, J. H., & Wellman, M. H. (1977). *Metamemory.* In R. V. Kail, Jr. & J. W.

Feuerstien, R. (1979). *Instrumental enrichment.* Baltimore, MD: University Park Press.

Fleming, M., & Levie, H. (1978). *Instructional message design.* Englewood Cliffs, NJ: Prentice Hall.

Fuqua, D. R., & Kurpious, D. J. (1993). Conceptual models in organizational consultation. *Journal of Counseling and Development, 71,* pp. 607-617.

Gagne, R. M., & Glaser, R. (1987). Foundations in educational research: In R. M. Gagne (Ed.), *Instructional Technology: Foundations.* Hillsdale, NJ: Lawrence Erlbaum.

Gardner, H. (1987). The theory of multiple intelligences. *Annals of Dyslexia 39, pp.* 19-35.

Gardner, H. (1989). Toward more effective arts education, special issue: Art, mind and education. *Journal of Aesthetic Education, 22*(1), pp. 157-167.

Gardner, H. (1993). *Creating minds: An anatomy of creativity as seen through the lives of Freud, Einstein, Picasso, Stravinsky, Eliot, Graham, and Gandhi.* New York, NY: Basic Books.

Gardner, H. (1993). *Multiple intelligences: The theory in practice.* New York, NY: Basic Books.

Gardner, H. (1993b). *Creating minds.* New York, NY: Basic Books.

Gardner, H., & Hatch, T. (1989). Multiple intelligences go to school: Educational implications of the theory of multiple intelligences. *Educational Researcher, 18(8),* pp. 4-9.

Gardner, H., Kornhaber, M. L., & Wake, W. K. (1996). *Intelligence: Multiple perspectives.* New York, NY: Harcourt-Brace.

Garofalo, J., & Lester, F. K. (1985). Metacognition, cognitive monitoring, and mathematical performance. *Journal for Research in Mathematics Education, 16(3),* pp. 163.

Garland, D. J., & Barry, J. R. (1990a). Sport expertise: The cognitive advantage. *Perceptual and Motor Skills, 70,* pp. 1299-1314

Garland, D. J., & Barry, J. R. (1991). Cognitive advantage in sport: The nature of perceptual structures. *The American Journal of Psychology, 104,* pp. 211-228.

Gold, J. M., (1995). An intergenerational approach to student retention. *Journal College Student Development, 36,* pp. 182-187.

Harris, J. E. (1984). Remembering to do things: A forgotten topic. In J. E. Harris (Ed.), *Everyday Memory Actions and Absent Mindedness* (p. 71-72). London: Academic Press.

Hirst, W., Spelke, E. S., Reaves, C. C., Caharack, G., & Neisser, U. (1980). Dividing attention without alternation of automaticity. *Journal of Experimental Psychology, 109,* pp. 98-117.

Insel, P. M., & Moos, R. H. (1974). Psychological environment: Explaning the scope of human ecology. *American Psychologist, 29,* pp 179-188.

Klapp, S. T., & Ntick, A. (1988). Multiple resources for processing and storage in short term working memory. *Human Factors, 30*(5), pp. 617-632.

Klatzky, R. L. (1980). *Human memory: Structures and processes.* San Francisco, CA: Freeman.

Koriat, A., Ben-Zur, H., & Nussbaum, A. (1990). Encoding information for future action: Memory for to-be-performed versus memory for to-be-recalled tasks. *Memory and Cognition, 18,* pp. 568-583

Kuh, G. D. (1991). Snapshots of campus community. *Educational Record, 72,* pp. 40-44

Kvalseth, T. (1978). Human and Baysian information processing during probabilistic inference tasks. *IEEE Transactions on Systems, Man, and Cybernetics, 8,* pp. 224-229.

Lester, F. K., Jr. (1988). *The teaching and assessing of mathematical problem solving*. Hillsdale, NJ: Lawrence Erlbaum Associates.

Logan, G. D. (1988b). Automaticity, resources, and memory: Theoretical contraversies and practical implications. *Human Factors, 30*(5), pp. 583-598.

Mackworth, J. (1959). Paced memorizing in the continuous task. *Journal of Experimental Psychology, 58,* pp. 206-211.

Miller G. A. (1956). The magical number seven plus or minus two: Some limits on our capacity for processing information. *Psychology Review, 15, pp.* 31-49.

Mogford, R. H., & Tansley, B. W. (1991). *The importance of air traffic controller's mental model.* Paper presented at Human Factors Society of Canadian Annual Meeting, Canada.

Moray, N. (1980). *Human information processing and supervisory control.* Technical Report. Cambridge, MA: M. I. T. Man-Machine Laboratory.

Moray, N. (1986). Monitoring behavior and supervisory control. In K. R. Boff, L. Koffamn, & J. P. Thomas (Eds.) *Handbook of perceptual human performance: Volumn II, Cognitive processing and performance* (p. 40-1 – 40-51). New York, NY: Wiley-Interscience.

Nora, A., Cabrera, A., Hagedorn, I. S., & Pascarella, E. (1996). Differential impacts of academic and social experiences on college-related behavior outcomes across different ethnic and gender groups at four-year institutions. *Research in Higher Education, 37,* pp. 427-451.

Pascarella, E. T., & Terenzina, P. T., (1991). *How colleges effect students: Findings and research from twenty years of research,* San Francisco, CA: Jossey-Bass.

Piaget, J. (1928). *The language and thought of a child.* New York, NY: Harcourt-Brace.

Piaget, J. (1965). Les tudes sociologiques. Genve: Droz Radziszewska, B. & Rogoff, B. (1988). Influence of adult and peer collaborators on children planning skills. *Developmental Psychology, 24,* 840D848.

Rogers, C. R., & Freiberg, H. J. (1994). Freedom to Learn (3rd Ed). Columbus, OH: Merrill/Macmillan.

Rouse, W. B. (1973a). Model of human in a cognitive prediction task. *IEEE Transactions on Systems, Man, and Cybernetics, 3,* pp. 473-478.

Rouse, W. B. (1973b). *Model of man as a suboptimal controller.* NTIS No. N75-19126/2), Cambridge, MA: M. I. T., Ninth Annual NASA Conference on Manual Control.

Shneiderman, B. (ben@cs.umd.edu) (February 2002) A New Agenda for Computing Professionals, The Human-Computer Interaction Lab (HCIL) at the University of Maryland.

Schroeder, C. C., & Hurst, J. C. (1996). Designing learning environments that integrate curricular and co-curricular experiences. *Journal of College Student Development, 37,* pp. 174-181.

Strange, C. (1994). Student development: The evolution and status of an essential idea. *Journal of College Student Development, 35,* pp. 399-411.

Stein, E. S., & Garland, D. (1993). Air traffic controller working memory: considerations in air traffic control tactical operation, Technical report, National Technical Information Service, Springfield, VA.

Teele, S. (1995). The relationship of multiple intelligences to the instructional process. Dissertation Abstracts International. (University Microfilms International No. 9501918).

Teele Inventory of Multiple Intelligences. Redlands, CA: Teele & Associates.

Teele, S. (1996). *Reforming the educational system to enable all students to succeed.* Paper presented at the annual conference of the National Association of Seondary School Principals, San Francisco, CA.

Terenzini, P. T., & Pascarella, E. T. (1994). Living with myths: Undergraduate education in America. *Change, 26,* pp. 28-32.

The Carnegie Foundation for the Advancement of Teaching. (1990). *Campus Life: In search of community.* Princeton, NJ: Princeton Press

Tierney, W. G., (1992) An anthropological analysis of student participation in college. *Journal of Higher Education, 63,* pp. 603-613.

Tinto, V. (1975). Dropout from higher education: A theoretical synthesis of recent research. *Review of Educational Research, 45,* pp. 89-125b.

Vygosky, L. S. (1978). Interaction between learning and development. In M. Cole, V. John-Steiner, S. Scribner, & E. Sougerman (Eds.) *Mind in society: The development of higher psychological processes* (p. 79-91). Cambridge, MA: Harvard University Press.

Western Institute for Higher Education. (1973). *The ecosystem model: Designing campus environments.* Boulder, CO: Western Interstate Commission for Higher Education.

Wertsch, J. (1994, Nov-Dec). Commentary: Reclaiming the natural line in

Wickens, C. D. (1984). *Engineering psychology and human performance.* Glenview, IL: Scott, Foresman & Company.

Wickens, C. D.,& Flach, D. M. (1988). Information processing. In E.L. Wiener & D. C. Nagel (Eds.), *Human Factors in Aviation.* San Diego, CA: Academic Press.

Wickens, C. D., Sandry, D., & Vidulich, M. (1983). Compatibility and resource competition between modalities of input, central processing, and output: Testing a model of complex task performance. *Human Factors, 25,* pp. 227-248.

Wilensky, R. , (1983). *Planning and understanding. A computational approach to human reasoning.* Chicago, IL: Addison-Wesley Publishing Company.

Yntema, D. B. (1963). Keeping track of several things at once. *Human Factors*, 6, pp. 7-17.

Zeitlin, N. J., & Finkleman J. M. (1975). Research note: Subsidiary task techniques of digit generation and digit recall as direct measures of operator loading. *Human Factors, 17,* pp. 218-220.

APPENDIXES

APPENDIX A

INFORMED CONSENT FORM

Informed Consent Form

For research conducted under the auspices of Oklahoma State University – Tinker AFB - Location.

You are being asked to participate in a study of, "THE ENHANCEMENT OF COGNITIVE AND METACOGNITIVE SKILLS DEVELOPMENT." This study is conducted by Deborah Lynn Tice. The purpose of the study is to examine the relationship of certain learner and instructional characteristics of metacognitive development.

If you choose to participate, you will respond to the Teele Intellegence Inventory and be given opportunities throughout the course to demonstrate learning gains in you preferred intelligence. The initial evaluation should take about 20 minutes.

All information obtained about you in the course of the study will be kept confidential. All information derived from the study will be reported in group results, not individual results.

Your participation in this study is voluntary, so there is no penalty should you decide not to participate. Furthermore you may withdrawn from the study at anytime without penalty.

If you desire further information about the study and/or your participation, please contact Debby Tice at (405) 498-7936.

I consent to participate in the study previously described. I understand that the scores and any other information about me will be kept confidential. I also understand that I am free to refuse to participate and to withdraw from the study at any time without prejudice to me. Furthermore, I understand that, if I am participating in this study to obtain course credit and I decide to withdraw from the study it will have no impact on my obtaining course credit.

______________________________ ______________________________
Student Name (printed) Student's ID Number

______________________________ ______________________________
Student's Signature Date

APPENDIX B

DATA COLLECTION INSTRUMENT

THE TEELE INVENTORY OF MULTIPLE INTELLIGENCES

NAME:______________________SCHOOL:______________________

DATE:______________________ Please Circle: AM or PM Classes

ANSWER SHEET

	A	B
1		
2		
3		
4		
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11		
12		
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14		

	A	B
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25		
26		
27		
28		

Total	Linguistic	Logical Mathematical	Intrapersonal	Spatial	Musical	Bodily	Interpersonal

Dominant Intelligences

1	2	3	4

APPENDIX C

INSTITUTIONAL REVIEW BOARD

APPROVAL FORM

Oklahoma State University
Institutional Review Board

Protocol Expires: 3/8/02

Date : Friday, March 09, 2001 IRB Application No ED99111

Proposal Title: ENHANCING METACOGNITION THROUGH THE USE OF MULTIPLE INTELLIGENCE

Principal
Investigator(s) :

Deborah Tice
317 Willard
Stillwater, OK 74078

H.C. McClure
317 Willard
Stillwater, OK 74078

Reviewed and
Processed as: Exempt

Approval Status Recommended by Reviewer(s) : Approved

Signature : [signature]

Carol Olson, Director of University Research Compliance

Friday, March 09, 2001
Date

Approvals are valid for one calendar year, after which time a request for continuation must be submitted. Any modifications to the research project approved by the IRB must be submitted for approval with the advisor's signature. The IRB office MUST be notified in writing when a project is complete. Approved projects are subject to monitoring by the IRB. Expedited and exempt projects may be reviewed by the full Institutional Review Board.

APPENDIX E

THE TEELE INVENTORY OF MULTIPLE INTELLIGENCE

Sue Teele, Ph. D., is the Director of Education Extension at the University of California, Riverside and has created a spatial inventory entitled The Teele Inventory for Multiple Intelligence (TIMI) which is used in over 6,000 locations and in nine countries. This inventory can be used with children as young as two years of age to gain an understanding of how they learn. She has written four books, the last two are The Multiple Intelligences School: A Place For All Students to Succeed and her newest book, released in July 1999 entitled Rainbows of Intelligences: Exploring How Students Learn. Her research areas focus on understanding the multiple ways individuals process information, multiple measures of assessment, literacy and learning and matching students' abilities to appropriate careers.

Dr. Teele, an internationally renowned speaker, author of The Multiple Intelligence School – A Place for All Students to Succeed and The Teele Inventory for Multiple Intelligences (TIMI). This is not just another video about understanding multiple intelligences. The focus of this comprehensive multimedia package is teaching – how to use multiple intelligences in the classroom. Dr. Teele's presentation is filled with practical examples and supplemented with classroom scenes illustrating teaching to multiple intelligences. And, most importantly, this package contains the TIMI for use by both teachers and students to help them both begin to discover their own talents and strengths.
An inventory developed in 1992, entitled, Teele Inventory for Multiple Intelligences (TIMI) is specifically designed to examine the dominant intelligences of students in kindergarten through the twelfth grade, and acts as an indicator as to whether or not students in different grade levels possess different intelligences.
The TIMI is a forced choice pictorial inventory that contains 56 numbered pictures of panda bears representing characteristics of each of the seven intelligences and provides students twenty-eight opportunities to make their selections of two choices. The different intelligences are matched with one another and students have eight different times they can select each of the seven intelligences. Students are asked to select one of the two choices that they feel is the most like them. There are no right or wrong answers. When completed, the resulting data is compiled, and then the inventory identifies the dominant intelligences each participant possesses. The intelligences have been coded by number and by letter, and can be tallied on the answer sheet by either the instructor or student. The answer sheet is easily scored and presents a profile of the responses enabling the student and teacher to determine the students most dominant intelligences as indicated by the highest scores.

An analysis of over 4,000 answer sheets has revealed some interesting data that could affect the way instruction is provided at different grade levels. Students at the primary level demonstrated a much stronger preference for linguistic and logical-mathematical intelligences than students at the middle and high school levels. Primary students most dominant intelligences were spatial, bodily-kinesthetic, linguistic and logical-mathematical while upper elementary students were spatial, bodily-kinesthetic, interpersonal and musical. Middle and high school students were strongest in interpersonal, bodily-kinesthetic, spatial and musical intelligences. The guide contains introductory activities, discussion questions, classroom application suggestions, reproducible Participant Packages, plus detailed instructions to ensure the success with TIMI use.

By Dr. Sue Teele
Director of Education Extension
University of California, Riverside

E-Mail: steele@ucx.ucr.edu

VITA 2

Deborah Lynn Tice

Candidate for the Degree of

Doctor of Education

Thesis: ENHANCING METACOGNITION THROUGH THE USE OF MULTIPLE INTELLIGENCE

Major Field: Applied Educational Studies

Biographical:

Personal Data: Born in St. Louis, Missouri in April, 1957, the daughter of Betty Jean Moss.

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