EFFECTS OF CONTEXT, COGNITIVE STYLE AND GENDER ON PROBLEM SOLVING

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TITLE PAGE

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A THESIS PROPOSAL SUBMITTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE (M.Sc.) DEGREE IN EXPERIMENTAL PSYCHOLOGY

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CERTIFICATION

I **CHIJIOKE, ANDREW ONWUEGBUCHULAM** a postgraduate student of the Department of Psychology University of Nigeria, Nsukka with the registration number **PG/MSc/12/62905** has satisfactorily completed the requirements for course and research work for the award of Master of Science (M.Sc) degree honours in Experimental Psychology. The work embodied in this dissertation is original and has not been submitted in part or full for any other diploma or degree of this or any other University.

________________________	________________________
Rev. Sr. Dr. M. B. Nwoke	Dr. Chris, N. Uzondu
Supervisor	Head of Department
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Prof. I. Madu	External Examiner
Dean, Faculty of the Social Sciences	

DEDICATION

To God Almighty for making me who I am

To my entire family for accepting the challenge of assisting me

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ABSTRACT

This study investigated the effects of context, cognitive style and gender on problem solving. Two hundred and forty (120 males and 120 females) SSII and SSIII students of University of Nigeria Secondary School, Enugu Campus (UNEC) were used as participants. Participants age ranged from 14-19 years with means age of 16.5 years. Two sets of materials used were the Oltman, Raskin, Heman and Witkin (1971) Group Embedded Figures Test (GEFT) used to classify participants into field dependent and field independent cognitive styles and the puzzle box that was used to measure problem solving. A 2x2x2 factorial design was adopted and a three way analysis of variance (ANOVA) was used to test the hypotheses. Results showed a non significant effect of context on problem solving; there was a significant effect of cognitive style on problem solving. Those with independent cognitive style were better at problem solving than those with dependent style. Result also showed a significant gender effect on problem solving. Male participants performed better than female participants. The only significant interaction effect was that of context x gender. Results were discussed and suggestion for further studies stated.

CHAPTER ONE

INTRODUCTION

Problem solving is used in many disciplines, sometimes with different perspectives, and often with different terminologies. For instance, it is a mental process in psychology and a computerized process in computer science. Problem can also be classified into two different types: ill-defined and well-defined from which appropriate solutions are to be made. Ill-defined problems are those that do not have clear goals, solution paths, or expected solution while well-defined problem have solution paths and clear expected solution and so allow for more initial planning than ill-defined problems. Being able to solve problems sometimes involve dealing with pragmatics (logic and semantics interpretation of the problem). The ability to understand what the goal of the problem is and what rules could be applied represents the key to solving the problem. Sometimes the problem requires some abstract thinking and coming up with a creative solution.

Problem solving can be seen as a cognitive processing aimed at figuring out how to achieve a goal. It involves cognitive (controlled) rather than automatic processes. Eysenck and Keane (2005) viewed problem solving as a tool, a skill and a process. It is a tool because it can help one to solve an immediate problem or to achieve a goal. It is a skill because once one has learnt it; one can use it repeatedly, like the ability to ride a bicycle, add numbers or speak a language. It is also a process because it involves taking a number of steps. A problem is any given situation that differs from a desired goal or a request for a satisfiable outcome to a situation (Reber, & Reber, 2001).

Sternberg (2003), Schacter (2000), and Kimura (1996), have shown that problem solving is a cognitive task that requires the solver to undergo through some cognitive processes of thinking, deciding, reasoning, understanding the language of the problem, and recollecting information stored in memory. Cognitive psychologists assert that problems are created when there is a mismatch between two factors. It therefore, means that those situations that have obvious solutions cannot be regarded as problems. Bransford and Stein (1993), Hayes (1989), Pretz Naples and Sternberg (2003), showed that people engage in problem solving when people need to overcome obstacles, to answer a question or to achieve a goal. If people can quickly retrieve an answer from memory, we do not have a problem. If people cannot retrieve an immediate answer, then people have a problem to be solved (Schwarz & Skurnik 2003). Motivation also greatly affects how people solve problems and whether people ever complete them.

Zimmerman and Campillo (2003) explained that problem solvers pass through seven processes/steps while solving problem. The first is Problem Identification: - As odd as it sounds, identifying a situation as problematic is sometimes a difficult step. For example, we may fail to recognize that we have a goal or fail to recognize that a path to a goal is obstructed or fail to recognize that the solution we had in mind does not work. Thus, if for example, ones problem is the need to write a term paper, one must first have the ability to identify a question that the term paper will address. The second is problem definition and representation: Once people identify the existence of a problem, people still have to define and represent the problem well enough to understand how to solve it. The third is strategy formulation**:** - Once the problem has been defined effectively, the next step is to plan a strategy for solving it. The strategy may involve analysis (breaking down the whole of a complex problem into manageable elements) or perhaps in addition, it may involve the complementary process of synthesis (putting together various elements to arrange them into something useful).

The fourth is Organization of information: - at this stage, the problem solver tries to integrate all of the information that will be needed to effectively do the task at hand. It might involve collecting references or even collecting your own ideas. This stage is critical to good problem solving. Sometimes, people fail to solve a problem not because they cannot solve it, but because they do not realize what information they have or how they fit together. Once a strategy (at least a tentative strategy) has been formulated there is the need to organize the strategy throughout the problem -solving cycle by constantly organizing and reorganizing the available information. This may require the use of an outline or representing the available information in the form of a map. The fifth step is resources allocation**:-** In addition to other problems there is the problem of having limited resources. These resources include time, money, equipment, and space. Some problems are worth a lot of time and resources while others are worth very few resources. Moreover, people need to know when and how to allocate which resources. Studies show that expert problem solvers (and better students) devote more of their mental resources to global (big picture) planning than do novices (and poorer students) who tend to allocate more time to local (detail-oriented) planning (Larkin & associates, 1980, Sternberg; 1981). Also, better students are more likely than poorer students to spend more time in the initial phase, deciding how to solve a problem, and less time actually solving it (Bloom & Broder, 1950). By spending more time in advance deciding what to do, effective students are less likely to fall prey to false starts, winding paths, and all kinds of errors. When a person allocates more mental resources to planning on a large scale he or she is able to save time and energy and to avoid frustration later on.

The sixth is Monitoring**:** A prudent expenditure of time includes monitoring the process of solving the problem. Effective problem solvers check up on themselves all along the way to make sure that they are getting closer to their goal. If they are not, they reassess what they are doing. They may conclude that they got off track somewhere along the way, or even that they see a more promising path if they take a new direction. The seventh is evaluation: just as there is the need to monitor a problem while in the process of solving it, there is also the need to evaluate the solution. Often key advances occur though the evaluation process. Through evaluation, new problem may be recognized or the problem at hand may be redefined and new strategies many come to light. New resources may also become available or, existing ones may be used more efficiently. Hence the cycle is completed when it leads to new insight and begins anew. The problem solving cycle can be represented in a chart as shown below.

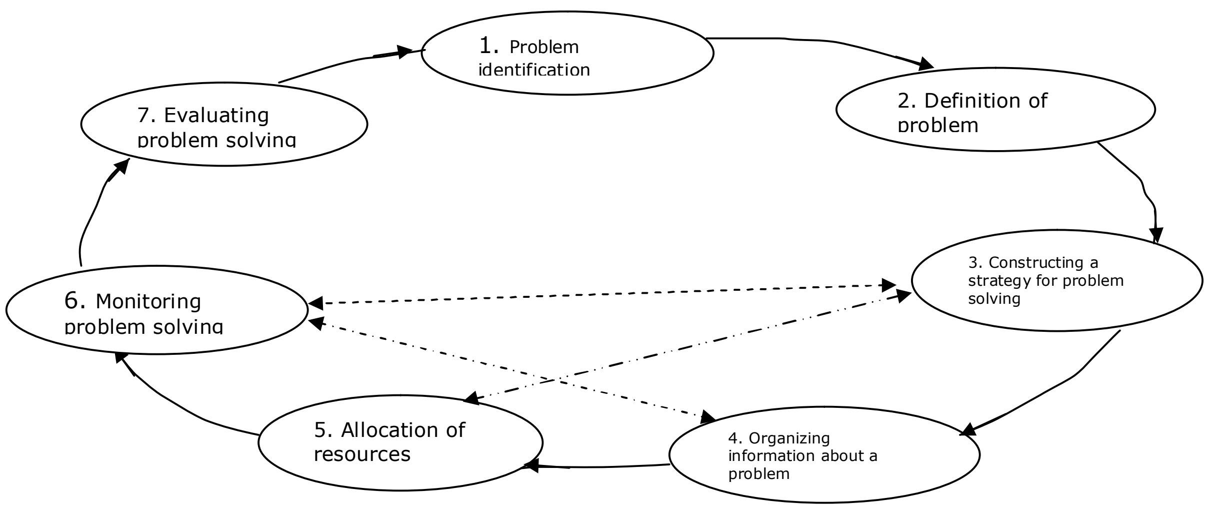


Figure 1: Problem Solving Cycle

Source: Zimmerman and campillo (2003)

Zimmer-man and Campillo (2003) posit that successful problem solving may involve occasionally tolerating some ambiguity regarding how best to proceed. Rarely can one solve problems by following any one optional sequence of problem solving steps. Moreover, one may go back and forth through the steps, change tactics when it seems appropriate. Most of the times, however, expert problem solvers do not continually use the problem solving cycle to solve new problems because of habituation, experience and practice.

Vygostsky (1986) asserts that culture affects the development, conceptualization, thinking, and how people approach problems. Culture encompasses ethnic traditions, language, religion, art, altitude, behavior and many other aspects. Language is one area of culture that very likely influences problem solving. Whorf (2003) proposed the linguistic ñreactivating hypothesisò which states that perception of the world is dependent on the structure and vocabulary of an individualôs language. It implies that, if a language does not have a word for a particular idea, it is very difficult for that idea to be conceptualized. Gestalt psychologists also introduced the concept of insight into problem solving process at the start of the twentieth century, in part, as a response to the theory of associationism, the dominant cognitive theory of the day. Associationism viewed insight as nothing more than an exercise in following a sequence of pre-established associations or more simply stated, stimulus-response associations (Mayer, 1995). The Gestalt psychologists argued for an alternative view, that "insight is a process that differs in kind from ordinary kinds of information processes" (Sternberg & Davidson, 1999, p. 63). They also proposed that, "under certain circumstances, organisms could achieve insight into a problem - this is, through analysis of the problem, the thinker could achieve a solution, even though there had not been extensive experience in the problem situation" (Weisberg, 1995, p. 159).

Gestaltists associated the concept of insight with understanding the underlying structure of a problem and the new relations among the problem components. The goal of their research was to study "how people understand how to solve problems that require a creative solution" (Mayer, 1995, p, 5) as well as, what prevented people from doing so when it appeared they possessed appropriate knowledge. They considered insight to be the result of restructuring, a shift in cognitive perspective, which enabled the problem solver to see the problem in a new and appropriate light. There are many theories regarding the processes that hinder or enhance the problem solvers' behavior to make this transition or shift from a non-solution state to a solution state (see in Chapter Two). Largely, obstacles that cause a problem solver to become fixated through misinterpretations also hinder the problem solver from discovering any new or more appropriate interpretations. If the obstacles are not overcome perceived progress is absent and the problem solver is said to have reached an impasse. An impasse is the point or condition in which the problem solver does not know what to do next. The problem solver would then be required to do something new and different in order to overcome this constraint. According to Gestalt psychologists, the problem solver would have needed to implement productive thinking defined as the "ability to go beyond past experience and produce something new in response to the demand of the problem" (Weisberg, 1995, p.161). As such, Gestaltists theorized that productive thinking applied to only certain types of problems, problems that were considered non-routine and which required the problem solver to go beyond past experience and come up with something novel and creative. Whereas, routine problem solving utilized reproductive thinking which implied a solution may be found though the direct application of previously gained knowledge. Because the thrust of Gestaltist research focused on productive thinking, they often utilized insight problems as problem solving tasks. They considered insight problems to be different from other more routine problems, and proposed that solving insight problems involved the process of restructuring. They also used "fixation deliberately because they believed that an inappropriate representation was a force directing problem-solving efforts and providing resistance to a new interpretation" (Dominowski & Dallob, 1995, p,45).

Some modern cognitive psychologists have accused the Gestaltists of being soft scientists, with vague answers to vague questions, as measurement seldom appears in the Gestalt approach (Gruber & Wallace, 1999). Others have proposed "that Gestalt psychologists work on hard questions, whereas modern cognitive psychologists sometimes prefer to work on easy ones" (Mayer, 1995, p. 26). Even so, Gestalt theories have "played an important yet controversial role in psychological theorizingñ(Weisberg, 1995, p. 158) and still many of the old controversies continue to be debated, as new discoveries are confronted. One particular source of contention was noted by Martinsen (1995) as ñthe relation between experience and task performance in productive thinking has been a source of disagreement throughout decades of research" (p. 291). Gestaltists did not consider past experience to be irrelevant to problem solving, as sometimes implied in research literature, "They did claim that past experience was insufficient to explain instances of productive problem solving or failures to think productively" (Dominowski & Dallob, 1995, p, 40). They also "argued that insight need not rely on past experience, and in some circumstances such experience may actually impede creative production" (Baker-Sennett & Ceci, 1996, pt 168). In effect, habitual directions may act as a mental block, (eg, functional fixedness, when a problem solver cannot think of a novel use for an object because they are fixated on its original use only). Kaplan and Simon (1990) noted that for most problems, knowledge allows one to hack away irrelevant details and focus on the problem elements that are likely to be critical for a solution. But in insight problems, where the answer often lies is in very obscure place, inappropriate or irrelevant knowledge may guide search to an unproductive region of the problem space. (p. 399)

Others have claimed that (insight) problems cannot be solved without relevant experience or the availability of functions (Perkins, 1981; Weisberg & Alba, l981a, l981b) while others claimed that solving insight problems, just as any other type of problem solving activity is based on one's experience (Gick & Lockhart, l995). The idea is that "the insightful person must first build up a huge reservoir of discipline-relevant information" (Simonton. 1995, p, l7). That is why "one persons insightful problem solving may be another's routine problem solving, owing to difference in knowledge representations"

(Gick & Lockhart, 1995, p. 20 l). In some situations, "people who are experts at dealing with a particular domain may benefit from their prior knowledge in solving problems there" (Seifert et al, 1995, p. 1180); they can often size up a situation quickly and accurately, making decisions that appear to the novice as intuitive. Yet, Ippolito and Tweeney (1995) warned that the theory of expertise based largely on accumulated knowledge, dooms the expert to becoming the inhabitant of a golden cage..." (p. 448), they may become too committed to their knowledge base, and may experience conceptual tiredness that diminishes insight. Martinsen (1995) echoed this notion, in that ñexperience is conducive up to a point. Too much experience may make people become blind to what's new" (p. 443) and is therefore considered detrimental to performance. At times having more knowledge may actually interfere with the retrieval of information about the topic (Steinberg, 1995).

There also exists a third group of theorists, which proposed the existence of an inverted U relationship between experience and creativity (Maninsen, 1993). In other words, an optimal level of experience is needed for creativity. Stemberg and Lubart (1995) assert that ñfor creative insight, an intermediate level of knowledge may be optimal. With too little knowledge, major insights will not occur because there are not enough raw materials. Conversely, with too much knowledge, major insights will not occur because they would devalue one's current knowledge base. (p. 548). Martinsenôs (1993, 1995) explored the concept of a curvilinear relation between experience and creativity, with an underlying intent ñto offer a new perspective on the role of experience in problem solving" (Martinsen, 1993, p. 438). In his two studies, he specifically focused on the influence of individual differences in cognitive styles and experience on creative problem solving, as he "argued that the relation between experience and performance cannot be fully understood without recognizing individual differences" (Martinsen, 1995, p. 291). His findings offered some support to the notion that the two seemingly contradictory perspectives regarding relation of experience to insightful problem solving may be integrated. "The possibility suggested by Maitinsen's (1995) empirical demonstration is that there is an optimal level of experience for creative work" (Runco & Sakamoto, 1999, p. 66) that varies with an individualôs cognitive style.

Problem solving is also a skill which can enhance logical reasoning. Individuals can no longer function optimally in society by just knowing the rules to follow to obtain a correct answer. They also need to be able to decide through a process of logical deduction and sometimes need to be able to develop their own rules. For these reasons problem solving can be developed as a valuable skill in itself, a way of thinking (NCTM, 1989), rather than just as the means to an end of finding the correct answer.

Modern definitions of intelligence (Gardner, 1985) talk about practical intelligence which enables 'the individual to resolve genuine problems or difficulties that he or she encounters' (p.60) and also encourages the individual to find or create problems 'thereby laying the groundwork for the acquisition of new knowledge' (p.85).

Problem solving allows the student to experience a range of emotions associated with various stages in the solution process. Problem solvers also speak of the willingness or even desire to engage with a task for a length of time which causes the task to cease being a 'puzzle' and allows it to become a problem. However, although it is this engagement which initially motivates the solver to pursue a problem, it is still necessary for certain techniques to be available for the involvement to continue successfully.

In the past decade it has been suggested that problem-solving techniques can be made available most effectively through making problem solving the focus of educational curriculum. That is why such curriculum should be organized around problem solving, focusing on:

(i) developing skills and the ability to apply these skills to unfamiliar situations

(ii) gathering, organising, interpreting and communicating information

(iii) formulating key questions, analyzing and conceptualizing problems, defining problems and goals, discovering patterns and similarities, seeking out appropriate data, experimenting, transferring skills and strategies to new situations.

(iv) developing curiosity, confidence and open-mindedness (NCTM, 1980, pp.2-3).

One of the aims of teaching through problem solving is to encourage students to refine and build onto their own processes over a period of time as their experiences allow them to discard some ideas and become aware of further possibilities (Carpenter, 1989). As well as developing knowledge, the students are also developing an understanding of when it is appropriate to use particular strategies. Through using this approach the emphasis is on making the students more responsible for their own learning. There is also considerable importance placed on exploratory activities, observation and discovery, and trial and error. Students need to develop their own theories, test them, test the theories of others, discard them if they are not consistent, and try something else (NCTM, 1989). Students can become even more involved in problem solving by formulating and solving their own problems, or by rewriting problems in their own words in order to facilitate understanding. It is of particular importance to note that they are encouraged to discuss the processes which they are undertaking, in order to improve understanding, gain new insights into the problem and communicate their ideas (Thompson, 1985, Stacey & Groves, 1985).

A variable that may likely influence problem solving is context. Context is considered as the set of all entities which influence human cognitive behavior on a particular occasion (Kokinov, 1995). Various entities influence the cognitive process to different degrees. For example, the goal influences the problem solving process much deeper than a casual object in the problem solver's environment. Psychologists have demonstrated context effects on virtually all cognitive processes. Thus, for example, context effects on perception have been demonstrated by Gestalt psychologists in various forms: different interpretations of ambiguous figures; visual illusions depending on the background elements or on the presence of other stimuli. In language comprehension context effects can be exemplified by lexical, syntax, semantic, inference, thematic and other types of context effects (Tiberghien, 1988). In memory studies various effects of context have been demonstrated ï context-dependence of recall and even recognition, memory illusions in false recognition, context-based interference, priming effects, etc. (Levandowsky, Kirsner, & Bainbridge, 1989). In problem solving various forms of context effects have been demonstrated: functional fixedness (Dunker, 1945), set effects (Luchins, 1942), lack of transfer from previous problem solving experience (Gick & Holyoak, 1980), priming effects (Schunn & Dunbar, 1996), effects of casual elements of the environment (Kokinov & Yoveva, 1996). In decision-making various context effects have been demonstrated: framing effects ï the effects of alternative descriptions, e.g. percentage died or saved; effects of alternative methods of elicitation; and effects of added alternatives (Shafir, Simonson, & Tversky, 1993). Barsalou (1993) demonstrated context effects on concepts characterization. Thus every change in the experimental conditions that proved to change the behaviour of the subject is called a context effect. In the case of perception, language comprehension, problem-solving, and decision-making most often context effects can be described as a change to the external environment which causes a change to the cognitive performance or subjectsô response; in the case of learning, memory, and problem solving transfer (like in analogical problem solving) context effects typically demonstrated are due to the change of the external environment between the initial learning stage and the later memory or problem solving test. According to the dynamic theory of context (Kokinov, 1995) context is the set of all entities that influence human (or systemõs) behaviour on a particular occasion, i.e. the set of elements that produce context effects.

Two different notions of context (external and internal context) have been used in the literature. External context refers to the physical and social environment or the setting within which the subjectõs behaviour is generated (Roediger & Srinivas, 1993). Internal context refers to subjectõs current mental state (Sperber & Wilson, 1986) within which the subjectõs behaviour is generated.1 Obviously there is a relation between the external and internal contexts ï the external context is being perceived and this changes the mental state of the subject, i.e. his/her internal context. However, what part of the external context will be perceived and reflected is purely subjective and depends on subjectõs current state (incl. goals, currently used social and common sense schemas, currently active concepts, etc.), i.e. on subjectõs internal context.

Psychological experiments are typically manipulating external context and very rarely the internal context (exceptions are mood-dependence studies and priming effects). The dynamic theory of context (Kokinov, 1995) accepts that the internal context is being formed by the interaction between at least three processes: perception of the environment or building new representations; accessing memory traces or reactivating and possibly modifying old representations; and reasoning or constructing new representations. It also assumes that it is the internal context which on its turn influences perception, memory, and reasoning processes. The currently dominating view on context is model-based, i.e. it assumes the existence of a model of the cognitive process according to which some factors (e.g. the instructions, the stimuli, the goals of the subject) are variable and important for the process and are called inputs to the model while others are supposed to be either constant or irrelevant to the process and therefore they are not included in the modelôs inputs (they are ñhardwiredò in the model and can be considered as constants or parameters that rarely change). Thus if such a supposedly irrelevant factor turns out to influence subjectôs behaviour then this is called context effect and modelôs failure to predict the outcome of the experiment is explained by ñinteraction effectò. This view has been expressed very clearly by Bernard Amy (1989): ñContext effects are interactive effects, in the physical sense of the term. The course of an ongoing central process is modified by interaction with other ongoing processes. Contexts act not on the inputs of the central process but on the function itselfò. Similar views have been expressed by Davies & Thomson (1988b): ñAll distinctions of context assume a distinction between stimulus and setting, figure and groundò; and Lockhart (1988): ñThe vary phrase context effects assumes that it is both possible and useful to distinguish a core stimulus from other aspects of the total stimulus configuration and that core and context can be varied independentlyò. This view implies that the observer (external or internal) focuses on a specific part of the systemôs behaviour considering it as central and modelling it, and allows other contextual factors to influence or modify this central process, to redirect its focusing on different input data.

The dynamic theory of context assumes that the cognitive system is continuously changing and there is no clear difference between changing the input and changing the system itself. It assumes also that there is one global cognitive process described as the evolution of the system over time and that all more specific or partial processes that we are considering and modelling are only abstractions which allow us to simplify our scientific endeavour. Having this in mind then there is only one single global context for all these ñabstractò processes ï the state of the dynamic system. This is called intrinsic context of the cognitive system and is the focus of research of the dynamic theory of context. The intrinsic context includes what others characterize as ñfigureò, i.e. subjectôs current goals and focus of attention are part of the context and might be considered as its core or central part.

There are at least two different meanings of explicit/implicit used in the literature and both are relevant. The first one concerns the content of the memory traces ï whether they include a representation of contextual features. For example, whether subjects encode information about some specific feature of the room setting, of the experimenter, etc. when asked to remember a list of words. The traces may even include a meta-representation.

In the situated approach context is considered to be the interaction between the environment and subjectøs mind/body, thus there is no such separation between internal and external context (Shanon, 1999). Explicit/implicit context assumes model-based notion of context: the model assumes that room setting and experimenterøs face are irrelevant to the task of list memorising and therefore are contextual factors. Contextual features might also be implicitly represented, i.e. they could be inferred (reconstructed) from the content of other traces, e.g. the fact that there were a lot of broken glasses during the car crash last week might be inferred from our schema for a car crash (and might even be false in that particular case).

The second reading of implicit/explicit distinction (which is more relevant to the dynamic theory of context) concerns the subjectøs level of awareness of the very fact of existence of some memory trace. According to the dynamic theory of context the level of awareness is a graded (continuous) and dynamic characteristic of every memory element, i.e. there are various degrees of awareness measured by the amount of processing capacity currently associated with this particular element. In other words accessibility is a key measure of explicitness. At the lowest end a memory trace could be completely inaccessible (neither consciously, nor unconsciously) at a particular moment, then it could be only unconsciously (implicitly) available (demonstrated by priming effects, but failing to be recognised in an explicit memory task, for example), then it could be consciously available (demonstrated by a standard recall or recognition task), and finally the very fact of existence of the memory trace might be consciously available (demonstrated in a meta-cognitive ñfeeling of knowingò experiment). Both isolated contextual features and the context as a whole might be implicitly or explicitly available. While explicit availability allows for controlled use of contextual information, implicit availability serves a very important role in human cognition ï it is a fast and cheap way of automatic control of resource allocation. If resource allocation control was performed by conscious information processing strategies only, then human cognition would be very slow and inflexible.

Two different notions of context have also been used in the literature which will be called here different and same context. Different context refers to the physical and social environment or the setting within which the subjectôs behaviour is generated (Roediger & Srinivas, 1993). Same context refers to subjectôs current mental state (Sperber & Wilson, 1986, Kintsch, 1988) within which the subjectôs behaviour is generated. What part of the different context will be perceived and reflected is however purely subjective and depends on subjectôs current state (i.e goals, currently used social and common sense schemas, currently active concepts, etc.). How is the same context formed and how is it used? The dynamic theory of context (Kokinov, 1995) accepts that the same context is formed by the interaction of at least three processes: perception of the environment or building new representations; accessing memory traces or reactivating and possibly modifying old representations; and reasoning or constructing new representations. This in turn influences perception, memory, and reasoning processes.

The currently dominating view on context is model-based. It assumes the existence of a model of the cognitive process according to which some factors (e.g. the instructions, the stimuli, the goals of the subject) are variable and important for the process and are called inputs to the model while others are supposed to be either constant or irrelevant to the process and therefore they are not included in the modelôs inputs (they are ñhardwiredò in the model and can be considered as constants or parameters that rarely change). Thus if such a supposedly irrelevant factor turns out to influence subjectôs behaviour then this is called context effect and modelôs failure to predict the outcome of the experiment is explained by ñinteraction effectò. This view has been expressed very clearly by Amy (1989) who posits that context effects are interactive effects, in the physical sense of the term. The course of an ongoing central process is modified by interaction with other ongoing processes.

The main role of context is to provide humans with a much greater control over knowledge. Context permits defining which knowledge should be considered, what are its conditions of activation and limits of validity and when to use it at a given time (Bastien, 1992). This is especially important for the building and the use of large and reliable knowledge systems. Contexts act like adjustable filters for giving the right meaning in the current context and to present the minimal number of information pieces and essential functions that are necessary to the task at hand (Barthe, 1991). Brown and Carpenter (2002) assert that as context effect increases the motivational problem solving skill also increases. When used effectively, context can be a powerful motivational tool that can get students involved and interested in the problem skill development (Robert, 2011) and may inspire problem solvers to engage to a greater degree in a problem and to serve longer in solution attempts.

Studies relating to context and problem solving have been reported. For example, Ericson and Kintsch (2004) examined the difference between far and near context in problem solving using mathematics set. Result showed that those students who solved mathematics set in near context environment performed better than those in far context environment. Smith, Glenberg, and Bjork (1978) also studied the relationship between environmental context (off- campus and on-campus) and memory as measured by recall. They found that when participants were tested in the same room in which they had learned a list, they recalled 59% of the paired-associate word or mathematics but when tested in the different room in solving the problem, their recall performance dropped to 46%. Differential performance as a result of context effect has also been reported (see Kokinov & Yoveva, 2004; Hallgrimsson & Henry, 2012).

Another variable of primary interest in this study is cognitive style. Our ability to encode, store, and retrieve information from memories is one of the most important functions of our cognitive system (Nash, Brittary, Gene & Gregory, 2013). A comprehensive review of research in cognitive Psychology has indicated that people exhibit significant individual differences in the cognitive processing styles that they adopt in problem solving and other similar decision- making activities (Roberton, 1985). Findings from both qualitative and quantitative research have indicated several consistent major dimensions of individual differences (Riding & Cheema, 1991). Of these dimensions, cognitive style is a major one. The construct of cognitive styles was originally proposed by Alloport (1937), referring to an individualôs habitual or typical way of perceiving, remembering thinking, and problem solving. Since then especially in the last few decades, there has been additional considerable research in this area. Cognitive Style has been broadly investigated by psychologist. Messick (1976) identified as many as 19 cognitive styles.

Tennan (1988) defined cognitive style as ñan indivisible characteristic and consistence approach to organizing and processing informationò (P. 89). Riding, Glass and Douglas (1993) termed cognitive style as a ñfairly fixed characteristics of an individual that are static and are relatively in ï built features of the individualò (P. 268). Based on the above definitions, cognitive/learning styles refer to the individualôs consistent and characteristic predispositions of perceiving, remembering, organizing, processing, thinking and problem solving. Cognitive style was popularized , Goodenough and karp (1962). According to these authors, individuals adopt different perceptual approaches in solving problems. Some peoplesô perception is strongly dominated by the prevailing field (environment) and this mode of perception they designated as ñfiled-dependentò, while others who perceive items as more or less separate from the surrounding are designated as ñfield-independentò. These two dimensions of cognitive style were conceptualized as part of a characteristic of individual differences in processing and organization of social and cognitive information. One of the most consistent works on cognitive styles regarding field-dependence/independence was developed by Herman Witkin and his collaborators (lemes, 1998). The results of the individual differences observed could be defined by the level of dependences that the subject had of the structure of his visual field (Squire & Knowlton, 1993).

A critical aspect of field-independent thinking is that it leads to a single best answer, leaving no room for ambiguity in this view answers are either right or wrong. The solution that is derived at the end of the Field-independent thinking process is the best possible answer the majority of the time. Field-independent thinking is also linked to knowledge as it involves manipulation existing knowledge by means of standard procedures knowledge is another important aspect of creativity. It is a source of ideas, suggests pathways, suggests pathways to solutions, and provides criteria of effectiveness and novelty (Nielsen, Pickett & Simontion, 2008). Field-independent thinking is used as a tool in creative problem solving. When an individual is using critical thinking to solve a problem they consciously use standards or probabilities to make judgments. This contrasts with field-dependent thinking where judgment is deterred while looking for and accepting many possible solutions.

Hommel, Colzato, Fischer and Christofel (2011) ñField-dependent thinking refers to a through process or method used to generate creative ideas by exploring many possible solutions. It is often used in conjunction with field-independent thinking which follows a particular set of logical steps to arrive at one solution which in some cases is a ñcorrectò solution. Field-dependent thinking typically occurs in a spontaneous free flowing manner, such that many ideas are generated in an emergent cognitive fashion. Many possible solutions are explored in a short amount of time, and unexpected connections are drawn. After the process of Field-dependent thinking as been completed, ideas and information are organized and structured using Field-independent thinking.

Psychologists have found that high 1Q alone does not guarantee creativity. Instead, personality traits that promote Field-dependent thinking are more important. Personality traits that promote Field-dependent thinking include traits such as nonconformity, curiosity, willingness to take risks and persistence. (Razonmnikova, 2000). According to Bar (2009) activities which promote divergent thinking include creating lists of questions, setting aside time for thinking and meditation, brainstorming, subject mappingò/òbubble mappingò keeping artwork, and free writing. In free writing, a person will focus on one particular topic and write non-stop about it for a short period of time, in a stream of consciousness fashion. Therefore thinking is the process of generating multiple related ideas for a given topic or Field-dependent solution to a problem. Field-dependent thinking occurs in a spontaneous, free- flowing non-linear manner. Field-independent thinking on the other hand, is the ability to apply rule to arrive at a single correctò solution to a problem such as the answer to an 1Q test problem. This process is systematic and linear.

The idea of thinking has become important in the scientific study of creativity are measures of Individual differences in Field-dependent thinking ability.

Several studies have tried to investigate cognitive styles and problem solving. For example, Happel (1994) reported that when solving problems, accuracy in contrast varied significantly as a function of cognitive style with participants with field independent style being more accurate than their field dependent counterparts.

Squaire and Knowlton (1993) observed that those using many methods or formula from field-independent cognitive style have tended to find higher levels of knowledge than those using one method from field-dependent in solving the problem. These researchers studied a sample of 450 participants to quantify the effect of prompting on knowledge of mathematical problem solving of simultaneous equation and quadratic equation. Results demonstrated significantly higher knowledge of field-independent in problem solving when compared with those of field-dependent. Fischer and Christofel (2011) also reported that field-independent does not differ significantly from field-dependent in solving mathematical problem, but that the field-independent is substantially below that of field-dependent. Generally, most experimental studies indicate that field-independent is easier than field-dependent. (e.g. Mayer & Wiltrock, 1996).

Another phenomenon that may influence problem solving is gender. Gender refers to the learned characteristics and behavior associated with biological sex in a particular culture (Olson & Defrain, 2006) or in other words, as the entire standards of behavior that differentiate males from females in a given culture. The nature of the variable has led to the question: are there gender differences in problem solving? Thus, gender related differences have generated a great deal of controversy that relate to when and why they appear, their magnitudes, and their consequences (Halpern, 2000). Dealing with problem solving in life is often one of the occasions that differences between man and women become apparent. This is because, while both genders have the same goal of solving the problem, they may often go about finding a solution in a very different way to each other. These differences are often unconscious and to really understand these differences we need to have a basic understanding of the processes they go through to find a solution (Bar, 2009). When women try to solve a problem, they often rely on the help of those close to them. They will talk through their problem, discussing the situation in detail, and how they could solve it. The process of discussion is also important to women giving them the opportunity to strengthen the relationship with the person they are talking to.

A woman may consider a relationship to be weakened if the person they are talking to appears to be uninterested or unhelpful. On the other hand, men approach problem solving with much less communication. Instead, they will often dominate the problem solving process and will use it as a chance to demonstrate their knowledge and ability. Similarly to women the process of solving the problem is important, but for men it is important to solve the problem in the best and most effective way. Hyde (1990) posits that where gender differences do exist, they are in critical areas.

Indeed gender-related differences in problem solving abilities have generated a great deal of controversy. When and why they appear, their magnitude, and their consequences are hot issues in contemporary psychology (Murphy & Ross, 1987). It is arguable that males and females have different kinds of problem solving abilities and that the kinds of items appearing in problem solving tests happen to favour males.

Heather, Casper and Camp (1995) has reported that males score more highly than females on problem solving of General Science (- 45) and Government, where as females scores more highly on medicine (.25) and fashion (.09). Although females did better than was predicted, the magnitude of the effect of gender on problem solving of general knowledge provides strong evidence that male have a larger advantage on problem solving of general knowledge. Some studies have also concluded that the most age differences for problem solving strategy were highly dependent on the degree to which the situation was emotionally salient (Camp & Cameron, 1995). They found that male groups used both passive-dependent and avoidant-denial strategies more than female groups. Problem-focused strategies were used least in high emotionally salient situations. Cross culturally (Ghanaians and Norwegian participants) males performed significant better than females in both samples (Amponsah & Krekling, 1997).

Statement of the Problem

One factor that can hinder problem solving is mind set involving an existing model for representing a problem, a problem context, or a procedure for problem solving. When problem solvers have an entrenched mind set, they fixate on a strategy that normally work well in solving many problems but that does not work well in solving every problem.

Another type of mind set involves fixation on a particular use (function) for an object. Specifically functional fixedness is the inability to realize that something you know to have a particular use may also be used for performing other functions. Functional fixedness prevents us from solving new problems by using old tools in novel ways. Eysenck and Keane (2005) viewed problem solving as a tool, a skill and a process. It is a tool because it can help one to solve an immediate problem or to achieve a goal. It is a skill because once one has learnt it; one can use it repeatedly like the ability to ride a bicycle, add numbers or speak a language. It is also a process because it involves taking a number of steps. These mental set attached to context and cognitive style will therefore affect how we solve problems. There could also be gender difference in problem solving that requires to be well understood. This study is designed to provide answers to the following problems.

Will there be a significant effect of context on problem solving?

Will there be a significant effect of cognitive style on problem solving?

Will there be gender influence on problem solving?

Purpose of the Study

The aim of the study is to find out whether context, cognitive style and gender influence problem solving. Specifically, the study tends to:

Determine whether context will have significant effect on problem solving

Examine whether cognitive style will have significant effect of problem solving

Investigate whether gender influences problem solving

Operational Definitions of Terms

Context refers to same environment and different environment. Same environment refers to the administration of instruction and problem solving task in same environment while different environment refers to the administration of instruction in one environment and problem solving task in a different environment.

Cognitive style refers to a personòs style of processing information which can either be field-dependent or field-independent thinking as measured using group embedded figure test (GEFT) (Oltman, Raskin, Herman & Witkin 1971).

Gender refers to the attribute of being male or female

Problem solving refers to the cognitive process individuals adopt in finding solution to a problem. It is measured in this study using puzzle box.

CHAPTER TWO

Literature Review

This chapter reviews relevant literatures from two perspectives: theoretical and empirical reviews.

Theoretical Review

The following theories were reviewed in the study.

Information Processing Theory and Field Dependence-Independence

Meta theory of problem solving

Representational change theory

Progress Monitoring Theory

Gestalt theory

A Dynamic Theory of Context

Adaption-Innovation Inventory

Assimilator-Explorer (A-E) Cognitive Style Theory

Information Processing Theory and Field Dependence-Independence

Messick (1967) describes cognitive styles as ñinformation processing habitsò (p. 190) and proposed that such a characterization would improve further understanding of field dependence-independence perception functioning and problem solving. Differences in information processing behaviors between field dependent learners and field independent learners can be indicated as one explanation for variations in learning (Chinien & Boutin, 1993). Davis and Cochran (1989b) state that there is a link between field dependency and information processing in that field dependents are different from field independents in the three general stages of the information processing model of cognition: attentional processes in the sensory-memory stage, encoding of information into short-term memory, and the retrieval processes of long-term memory. Tinajero and Paramo (1997) reported that learners with different cognitive styles pay attention to different aspect of information; encode, store, and recall information differently; and think and comprehend in different ways. Thus, field dependent learners were found to be less efficient in analyzing, organizing, attending, encoding, and processing information (Davis, 1991).

Goodenough (1976) proposed a hypothesis that field independent learners and field dependent learners differ in terms of attentional processes. He states that in solving concept-attainment problems, field dependent learners are mainly dominated by the most noticeable or salient features of a stimulus. They tend to ignore many other features of a complex stimulus and are easily distracted by irrelevant cues. These differences become more amplified when the amount of information is increased and irrelevant cues are presented. A study by Blowers and OöConner (1978) supports Goodenoughös hypothesis. They found that, compared to field independents, field dependents used more time and had greater eye movement during the Rod-Frame Test, which implied that field dependent subjects have problems selectively attending to the relevant part of a visual field and need to scan more of the visual stimulus in the selection process. A study by Barrett, and Sterns (1981) reported that when participants were asked to attend to or isolate a relevant stimulus from a competing, irrelevant stimulus, field dependents were found to make more errors than field independents in both visual and auditory modes indicating that field dependent learners are generally less efficient in attending to relevant cues than field independent learners, especially when relevant cues are presented with distracting cues (Davis & Cochran, 1990).

Davis and Cochran (1982) proposed that there is a possibility that field dependent learners differ from field independent learners in encoding information into short-term memory/working memory. Cochran and Davis (1987) found that field independent learners have larger working memory capacity than field dependent learners. They concluded that field independent-dependent cognitive restructuring differences are related to working memory capacity and may influence verbal task performance. If field independent readers have more working memory capacity, they are likely to process textual integration during reading more efficiently than field dependent readers (Cochran & Davis, 1987). These results confirmed the impact of information-processing mechanisms on field dependent-independent differences (Cochran & Davis, 1987; Davis & Cochran, 1982). Frank (1983) studied encoding on a recall task using an encoding-specificity paradigm. The results of this study showed that field dependent and field independent learners had no differences in performance when the recall cues were the same as those presented during acquisition. However, when the recall cues were different, field independent learners performed better than field dependent learners in encoding processes. The difficulties with selecting attention also resulted in less efficient encoding, short-term memory, and long-term memory processes.

A study by Lange (1995) supported the notion that when cognitive load is high, only the most salient and vivid features are easily encoded by field dependents. It is then suggested that by providing field dependent learners ample time and practice activities, the encoding differences between field dependents and field independents could be accommodated (Berger and Goldberger, 1979). Davis and Cochran (1990) stated that memory differences exist between field dependent and field independent learners in some long-term memory storage and organizational processes they utilize in storing and retrieving information.

Meta- theory of Problem solving

Gagne (1999) posits that ñthe central point of education is to teach people to think, to use their rational powers, to become better problem solversò (1980, p.85). Most educators like Gagne, regard problem solving as the most important learning outcome from life because most people, especially professionals and trades people, are rewarded in their careers for their abilities to solve problems. No one is paid for memorizing information and completing examinations, very little education and training requires learners to solve problem and virtually none engages the kinds of problem solving encountered in the real world. At best education and training efforts engage learners in well-structured (text book) problems, while real world problems are nearly always ill-structured.

The ability to solve problems, they all believe is intellectually demanding and engages learners in higher-order thinking skills. Over the past three decades a number of information processing models of problem solving such as the classic general problem solver (Newell & Simon, 1972) have been promulgated to explain problem solving. The general problem solver specifies two sets of thinking processes associated with the problem solving processes, understanding processes and search processes. Another popular problem solving model, the IDEAL problem solver (Branford & Stein, 1984) describes problem solving as a uniform process, of identifying potential problems, defining and representing the problem, exploring possible strategies, and looking back and evaluating the effects of those activities. Gick (1986) synthesized these and other problem solving models (Greens, 1978) into a simplified model of the problem solving process, including the processes of constructing a problem representation, searching for solutions, and implementing and monitoring solutions. These information- processing conceptions of problem solving assume that the same processes applied in different contexts yield similar results. The culmination of this activity was an attempt to articulate a uniform theory of problem solving (Smith, 1991).

Problem solving is not a uniform activity. Problems are not equivalent, either in content form, or process. Schema-theoretic conceptions of problem solving opened the door for different problem types by arguing that problem solving skill is dependent on a schema for solving particular types of problems. If the learner possesses a complete schema for any problem type, then constructing the problem representation is simply a matter mapping an existing problem schema onto a problem. Existing problem schemas result from previous experience in solving particular types of problems, enabling the learner to proceed directly to the implementation stage of problem solving (Gick, 1986) and trying out the activated solution. Experts are better problem solvers because they recognize different problem states which invoke certain solutions (Sweller, 1988). If the type of problem is recognized then little searching through the problem space is required. Novices, who do not possess problem schemas, are not able to recognize problem types, so they must rely on general problem solving strategies such as the information processing approaches which provide weak strategies for problem solutions.

Progress Monitoring Theory

MacGregor, Ormerod and Chronicle (2001) have proposed a progress monitoring theory resembling Newell and Simonӧs (1972) theoretical approach. Two general problem-solving heuristics are of central importance within progress monitoring theory. The first is maximization heuristic: problem solvers try to make as much headway as possible towards goal attainment on each move; this is a form of means-end analysis heuristic method for solving problems based on noting the difference between a current and a goal state, and creating a sub-goal to overcome this difference. The second is progress monitoring: problem solver assesses their rate of progress towards a goal. Criterion failure occurs if the rate of progress seems to be too slow to solve the problem within the maximum permissible number of moves. What happens when problem solvers experience criterion failure? According to MacGregor and colleagues (2001), criterion failure leads problem solvers to seek an alternative strategy, and this in turn sometimes leads to insight. Thus, criterion failure acts as a ñwake up callò. Suppose participants are given a task, on which they nearly all initially adopt an inappropriate strategy. Conditions in which criterion failure is experienced rapidly should lead to faster problem solution than conditions in which criterion failure is only experienced later on. According to Ohlsson (1992) representational change theory, the key to developing insight on many problems is constraint relaxation. In other word, problem solvers need to realize that the range of permissible moves is greater than they had imagined. According to progress monitoring theory, constraint relaxation is often necessary but is not sufficient. More specifically constraint relaxation will facilitate problem solution much more for individuals experiencing criterion failure than for those who do not. MacGregor and colleagues explained in the nine-dot problem that the task is to draw four connecting lines to cover all the dots without lifting the pen from the paper. It has generally been assumed that the main difficulty people have with this problem is that they impose the constraint on themselves of keeping all the lines within the confines of the square. They found that telling participants to go outside the boundaries of the square improved performance, However, of crucial relevance to progress monitoring theory, those constraint-removing instructions were much more effective when given to participants who had experienced criterion failure than to those who had not, Thus, criterion failure was important in making people receptive to the constraint-removing instructions.

The key notion that insight is most likely to occur when constraint relaxation is combined with criterion failure has received good empirical support (MacGregor, et al.

2011; Ormeron et al, 2002). Thus, problem solvers who realize that mean-end analysis is proving unsuccessful are more responsive to changing their strategy than are those for whom means-end analysis is at least partially successful. To oversimplify a little, one need to experience real failure to maximize the chances that one will alter ones approach to a problem. Progress monitoring theory resembles the General problem solver (With its maximization heuristics), but has the advantage of considering motivational factors triggering strategy change in some detail.

In spite of the fact that criterion failure is an important factor in problem solving, it is clear that several other factors are important. For example, problem solversô previous experience with related problems influences the kinds of problem representations they produce. These representations in turn affect problem-solving performance. It may prove fruitful to combine elements of the progress monitoring theory and the representational change theory. More specifically, progressive monitoring theory predicts when problem solvers will seek insight and representational change theory predicts how insight is achieved.

Representation Change Theory

There have been various attempts to incorporate key aspects of the gestalt approach into an information-processing theory of problem solving. According to Ohlsson (1992), ñinsight occurs in the context of a block. This is unmerited in the sense that the thinker is competent to solve the problemò. The key assumptions of Ohlssonøs representational change theory are: the way in which a problem is currently represented or structured in the problem solverøs mind serves as a memory probe to retrieve related knowledge from long-term memory, the retrieval process is based on spreading activation among concepts of knowledge in long-term memory, a block/impasse occurs when problem representation is modified, the block is broken when the problem representation is changed. The new mental representation acts as a memory cue for relevant operators in long term memory thus, it extends the information available to the problem solver, changing the representation of a problem can occur in various ways: elaboration or addition of new problem information; constraint relaxation, in which inhibition on what is regarded as permissible are removed; Re-encoding, in which some aspect of the problem representation is reinterpreted (e.g. pliers can be a weight in the pendulum problem), lastly, insight occurs when an impasse is broken, and the retrieved knowledge operators are sufficient to solve the problem.

Ohlssonô theory is based squarely on gestalt theory. Changing the representation in Ohlssonôs theory is essentially the same as restructuring in the gestalt approach. Moreover, both theories emphasize the role of insight in producing problem solutions. What is the reason that some problems are easier to solve than their isomorphism (characterize as having the same form or the same formal structure)? Kotovsky, Hayes, and Simon (1985) have investigated extensively why some isomorphic forms are easier to solve than others. In particular, they studied various versions of a problem known as the Tower of Hanoi, in which the problem solver must use a series of moves to transfer a set of rings from the first of three pegs to the third of the three pegs, using as few moves as possible. They found that some forms of the problem took up to 16 times as long to solve as other forms. Although many factors influence these findings, the authors concluded that a major determinant of the relative ease of solving the problem was how the problem was represented in the mind of the solvers. For example, the physically different sizes of the disc facilitated the mental representation of the restriction against moving large discs onto smaller discs, whereas other forms of the problem did not. These finding is in line with the representational theory.

Changing the representation of a problem often leads to solution. For example, consider the mutilated draught board problem. Initially the board is completely covered by 32 dominoes occupying two squares each. Then two squares from diagonally opposite corners are removed. Can 31 dominoes fill the remaining 62 squares? Kaplan and Simon (1990) asked participants to think aloud while trying to solve the problem. They all started by mentally covering squares with dominoes. However, this strategy is not terribly effective because there are 758, 148 permutations of the dominoes. In order to solve the mutilated draught board problem, one has to form a new representation of the problem involving elaboration and re-encoding. If one represent each dominoes as an object covering one white and one black square (re-encoding), and represent the draught board as having lost two white (or two black) squares (elaboration), then it becomes clear that the 31 dominoes cannot cover the mutilated board.

Yaniv and Meyer (1987) found that their participantsô initial efforts to access relevant stored information were often unsuccessful. However, these unsuccessful efforts produced spreading activation to other concept stored in long-term memory. As a result, the participants were more likely to recognize relevant information when it was presented to them (e.g. noticing that the swinging string in the pendulum problem provides a solution). These findings are consistent with Ohlssonõs theory. Ohlssonõs theory that changing the problem representation (the gestaltsô restricting) often allows people to solve problems is an improvement on the gestalt approach because the mechanisms underlying insight are specified more precisely. More generally, the theory involves a fruitful combination of gestalt ideas with the information-processing approach. There are several limitations with representational change theory. First, it is often not possible to predict when (or in what way) the representation of a problem will change; for example, Ohlssonõs approach does not seem very successful when applied to the nine-dot problem.

More specially, Ohlsson predicts that instructions removing participants-imposed constraints will typically lead to problem solution, but this is not always the case (Macgregor, Ormerod, & Chronicle, 2001). Secondly, the theory is a single factor theory in that it is assumed that constraint relaxation is crucial to successful solution of insight problems. However, Kershaw and Ohlsson (2004) found with the nine-dot problem that multiple factors are involved and that hints to produces constraint relaxation had only a modestly beneficial effect. Thirdly, Ohlsson paid little attention to individual differences in problem solving skills and the ability to attain insight for example, it seems probable that highly intelligent individuals are more likely to show insight and solve complex problems than less intelligent ones. Fourth, the theory is more applicable to some problems than to others. For example, changing the problem representation is probably more important in the kinds of problems studied by Ohlsson and the Gestaltists than in other kinds of problems (e.g., solving a simple problem in mathematics) which are best approached in a systematic and methodical way.

Gestalt theory

Thorndike (1898) carried some of the earliest research on problem solving. Hunger cat in closed cage see a dish of food outside the cage. The cage doors could be opened when pole inside the cage was hit. Initially, the cats threshed about and clawed the sides of the urge however, after some time, the cat hit the pole inside the cage and opened the door. On repeated trial, the cats gradually learned what was required. Eventually they would hit the pole almost immediately, and so gain access to the food. Thorndike 1898) was unimpressed by the catsô performance, referring to their apparently almost random behavior as trial-and-error learning. There was a reaction against the above view by the Gestaltists. They argued that, Thorndikeǿs problem situation was unfair, because there was a purely arbitrary relationship between the catsô behavior and the desired goal. Their

(Gestaltists) understanding of problem solving emphasizes behaviour in situations requiring relatively novel means of attaining goals and suggests that problem solving involves a process called restructuring. Since this indicates a indicates a approach, two main questions have to be considered:

i. How is a problem represented in a person's mind?

ii. How does solving this problem involve a reorganization or reorganization of this representation? In current researches by cognitive psychologists, internal and external representations are distinguished: The first kind is regarded as the knowledge and structure of memory, while the latter type is defined as the knowledge and structure of the environment, such like physical objects or symbols whose information can be picked up and processed by the perceptual system autonomously. On the contrary, the information in internal representations has to be retrieved by cognitive processes. Problem representations are models of the situation as experienced by the agent. Representing a problem means to analyze it and split it into separate components: objects predicates, state space, operators and selection criteria, Therefore, the efficiency of Problem Solving depends on the underlying representations in a personøs mind, different dimensions, i.e. changing from one representation to another, results in arriving at a new understanding of a problem. This is what is described as restructuring. A key difference between approach and that of the Gestaltists is captured in the distinction between reproductive and productive problem solving. Reproductive thinking involves the re-use of previous experiences, and was the focus of Thorndikeøs research. In contrast, productive thinking involves at novel restructuring of the problem. It is more complex than reproductive problem solving, but the Gestaltists argued that several species are capable of this higher-level form of problem solving.

Kohler (1925) showed that animals could engage in productive problem solving. In one of his studies, an ape called sultan was inside a cage, and could only reach a banana the Cage, by joining two sticks together. The ape seemed lost at first. However, sultan then seems to realize how to solve the problem, and rapidly joined the sticks. According to Kohler. The ape had suddenly restructured the problem. By so doing, it had shown insight, which is often accompanied by the ñah-ha experience? There is one potential difficulty with Kohlerôs claimed demonstrations of insight in apes. The apes had spent the early months of their lives in the wild and so could have acquired useful information about sticks and how they can be combined. Birch (1945) found that apes rose in captivity shown little evidence of the kind of insightful problem solving observed by Kohler. Thus, the apparent insight by Sultan may have been due to a slow learning process rather than a sudden flash of insight.

Maier (1931) carried out a famous study on restructuring. The participants were given the ñpendulum problemò, and superficially, their performance was not as good as that Kohlerôs apes on insight problem. The most insightful solution was the pendulum solution. This involved taking the pliers, tying them to one of the strings, and then swinging the string like a pendulum. In this way, it was possible to hold one string and to catch the other on its upswing. Maier (1931) found it was possible to facilitate problem restructuring or insight by having the experimenter apparently accidentally brush against the string to set it swinging. Many participants produced the pendulum solution, but few reported having noticed the experimenter brush against the string. This finding is sometimes known as the unconscious cue effect. The Gestaltists claimed that insight involve special processes, and so is very different from normal problem solving. Metcalfe and Weibe (1987) reported relevant findings. They recorded participants feelings of ñwarmthò (closeness to solution) while engaged in solving insight and non-insight problems. There was a progressive increase in warmth during non-insight problems. With insight problems, there was a progressive Increase in warmth during non-insight problems. With insight problem, in contrast, the warmth ratings remained at the same low level until suddenly increasing dramatically shortly before the solution was reached. These findings suggest that insight is special, and occur in an all-or-none fashion. Novick and Sherman (2003) argued that people need to distinguish between their subjective experience and the underlying processes. They presented expert and non-expert anagram solvers with five letter anagrams, and ask them to indicate which out of various statements best describe how they arrived at the answer. One statement referred to insight or pop out solutions: the solution came to mind suddenly, seemingly out of nowhere. ñI have no awareness of having done anything try to get the answerò.

The percentage of pop-out solutions were 41% for the expert solvers and 22% for the non-experts. Most of these solutions were produced very rapidly (within 2-3 seconds of anagram presentation). The above findings indicate that insight occurs suddenly and does not involve the gradual accumulation of information.

Experience usually, benefit peopleôs ability to solve problem. However, Duncker (1945) argued, this is not always the case. He studied functional fixated-failing to see a tool in a new or unorthodox way. Maierôs pendulum problem can be seen as a case of functional fixedness, because participants failed to realize that pliers could be sued as a pendulum weight. Duncker (1989) gave his participants a candle, a box of nails, and several other objects. Their task was to attach the candle to a wall next to a table so it did not drip onto the table below. Most participants tried to nail the candle directly to the wall or to glue it to the wall by melting it. Only a few decided to use the inside of the nail-box as a candleholder, and then nail it to wall. According to Duncker, the participants ñfixatedò on the boxôs function as a container rather than as a platform. Solutions that are more correct were produced when the nail was empty at the start of the experiment, presumably because that made the box appears less like a container. Adamson (1952) reported similar result in a better-controlled experiment.

Weisberg and Suls (1973) argued that many participants given Dunckerôs candle problem failed to solve it because they hardly noticed the box had been available to solve the problem, 54% of them did not recall the box. Thus, it seems as if many participants failed to consider the box at all, rather than that they considered it and rejected it. Duncker assumed that functional fixedness occurred in his study because of the participantsô past experience with boxes. However, he had no direct evidence that past experience was the key factor.

On the positive side, the Gestaltists showed that problem solving often involves productive thinking as well as reproductive thinking. They emphasized the notions of problem restructuring and of insight, both of which remain influential concepts. In addition, their research findings provided suggestive evidence for both restructuring and insight. Another important contribution they made was to show that past experience can disrupt (rather than benefit) current problem solving, with their research on functional fixedness. On the negative side, the Gestaltists concepts such as insight and restructuring are rather vague and hard to measure. No clear idea of the processes underlying insight and restructuring. Subjectively, insightful solutions seem to occur suddenly out of nowhere, but insight may depend on the gradual accumulation of partial information (Novick & Sherman, 2003). Furthermore, the Gestaltists focused on a limited range of problem. Tending to ignore those (e.g. chess playing) in which the systematic accumulation of knowledge has primarily beneficial effects. Critical shows that some gestalt principles are overstated; others have very weak empirical support. However, the psychology reality of restructuring is not in doubt, in spite of the recent criticism by Weisberg and Suls.

A Dynamic Theory of Context

According to the dynamic theory (Kokinov, 1995) the implicit intrinsic intern context is considered as the dynamic fuzzy set of all memory elements (mental representations or operations) accessible for mental processing at a particular instant of time. Accessibility of a memory element is modelled by the degree of its activation which is supposed to reflect its estimated relevance (the better the element is connected to the other currently active elements the more relevant it is supposed to be). Thus context is implicitly represented by the distribution of activation over the set of all memory elements. Each pattern of activation represents a specific context. As activation is graded the membership of a memory element to this context is also graded and therefore its relevance is graded as well. This results in different amount of processing resources being made available to different memory elements (in DUAL cognitive architecture (Kokinov, 1994b) this is modelled by varying the speed of working of the mental operations and by varying the degree of accessibility of mental representations). This does not exclude to have explicit meta-context representations in addition. The implicit intrinsic internal context (i.e. the mental state of the cognitive system) can be self-observed and part of it (which is consciously accessible) can be explicitly represented in a local structure and afterwards referred to. However, this is always a partial representation of the actual mental state. The dynamic theory of context is being tested in two ways: (a) by psychological experiments on context effects on problem solving which have demonstrated that subjects are influenced in their problem solving activity even by seemingly irrelevant casual stimuli from the environment without always being aware of this influence (Kokinov, Yoveva, 1996,); and (b) by computer simulations of analogical problem solving (Kokinov, 1994a) replicating the priming effects shown earlier and predicting some of the data in the later conducted psychological experiments.

Recently a dynamic theory of context has been proposed (Kokinov, 1995) where context is considered as the set of all entities which influence human cognitive behavior on a particular occasion. All these context elements are elements of human working memory. Various entities influence the cognitive process to different degrees, e.g. usually, the goal influences the problem solving process much deeper than a casual object in the problem solver's environment. That is why instead of defining clear-cut boundaries of context it would be better to consider context as a fuzzy set of elements which gradually diminish their influence on human behavior. As a consequence, context is considered as the dynamic fuzzy set of all associatively relevant memory elements (mental representations or operations) at a particular instant of time.

There are various sources of context elements: reasoning mechanisms (the set of elements produced and manipulated by them is called reasoning-induced context), perceptual mechanisms (the set of elements produced by the perception process and representing entities from the environment is called perception-induced context), and memory mechanisms (the set of all elements retrieved/activated by memory processes or being a residue from a previous context is called memory-induced context).

The effects of the memory-induced context are usually described as set effects and priming effects while the effects caused by the perception-induced context are usually called simply context effects. There are many experiments on priming effects on perception, categorization, language comprehension, sentence completion, etc. Some experiments performed by the first author have demonstrated priming effects on problem solving (Kokinov, 1994a) with very clear dynamic properties: the priming effects disappear in the course of time according to an exponential law. Complementary, in the current work we are interested in context effects on problem solving.

A cognitive architecture DUAL has been proposed with a special emphasis on the context-sensitive nature of human cognitive processes (Kokinov, 1994b,c). A context-sensitive model of analogical reasoning, AMBR, has been developed on the basis of this architecture (Kokinov, 1994a). The performed simulation experiments with AMBR have replicated the priming effects obtained in the psychological experiments and in addition they made a prediction about context effects on problem solving. Part of the motivation of the current work is to test these predictions. The DUAL architecture explains context effects in the following way. The perceptual mechanisms build up representations of the objects in the environment and their properties and relations in the Working Memory (WM) or just reactivate existing representations in Long-Term Memory (LTM) and bring them into the WM. During the period of fixation on a particular object its representation becomes a source of activation, i.e. it continuously emits activation to its neighbors for that period. Moreover, depending on the location of the object in the visual field (center/periphery) and the amount of attention devoted to it, the amount of emitted activation will vary. The basic memory process in DUAL is a process of spreading activation where each WM element continuously spreads its activation to its neighbors. The resulting activation levels of the LTM elements determine their availability (accessibility for the declarative elements and speed of running for the procedural elements). The general predictions that this architecture makes are that (1) every element (be it part of the problem description or not) which is being perceived (and therefore activated in WM) can potentially influence the reasoning process if it happens that it is somehow linked (directly or via a chain of links) to a concept which can play a key role in the solution of the problem, (2) the more the element is attended to the higher its potential influence (if the distance between the element and the key concept is the same), i.e. generally the elements of the core of the contexts (e.g. the elements of the problem description) will have greater impact than the elements of the periphery of the context, (3) for a large number of elements that are not intentionally perceived their influence will be at the subconscious level and could not be reported by the subjects. Two experiments have been performed. In Experiment I the entities whose influence is being tested are part of the illustrations accompanying the target problem descriptions and are supposed to be attended to even if later on they can be considered as irrelevant, therefore they (rather) belong to the core of the context, while in Experiment II the tested entities are part of the illustrations accompanying other problems' descriptions, they are casual with respect to the target problem and might not be attended to at all, therefore they (possibly) belong to the periphery of the context (if a context effect could be demonstrated at all).

Assimilator-Explorer (A-E) Cognitive Style Theory

According to Martinsen (1995) "the theory of assimilative and explorative (A-E) cognitive styles (Kaufmann, 1979, 1983) has a particular potential to explain the relation among experience, problem solving and creativity" (p. 292), Kaufinannὀs A-E theory is "based on cognitive schema theory with special reference to Piagetὀs core concepts of assimilation and accommodation" (Martinsen & Kaufmann, 1999, p. 277). The postulate of the A-B cognitive-style theory is that differences exist between individuals and their tendency to rely on past experience when required to think in a new and different way and "these individual differences are linked to dispositions towards using general, heuristic strategies, which are posited to have implications for performance on different types of tasks" (Maitinsen, l994, p. 83). The two distinct A-E cognitive styles that lead to different approaches to problem are described as follows: Assimilators are seen as more rule-bound in problem solving behavior, and as having a disposition toward interpreting new events in terms of existing knowledge ... Explorers are seen as having the strongest disposition toward novelty seeking, which manifests itself in a search for new types' of solutions and new ways of solving problems without external pressure to do so. (Martinsen & Kaufmann, 1999, p. 277).

Martinsen asserted that cognitive style is an "important variable in determining how people deal with novelty as it describes .preferences for strategies or preferred ways of using one's abilities ά.. and that 'people differ in how they use their abilities in a given situation" (Martinsen, l993, pp. 436-437). As criterion for problem solving performance, insight problems were used in his research because they are generally considered ill-defined and high in novelty. Martinsen (l994, p. 86) further noted that "solving such tasks depends on basic, cognitive process such as search and restructuring. Performance on these tasks has also been linked to processes of creativity".

In his (1993) research Martinsen looked at the joint influence of cognitive style and experience on insight problem solving, and ñfound that Assimilators profited from a high level of relevant experience in problem solving, while Explorers performed better under conditions of low relevant experience" (Martinsen, 1994, p. 83). Results from Mattinsen's (1995) research, which sought to replicate and extend previous (1993) findings, indicated that "experience may have a facilitating or inhibiting effect on problem solving depending on the cognitive style orientation" (p. 291). These results would tend to support the existence of an inverted U relationship between experience and creativity. Additional research using other measures of cognitive style should be carried out as a way of testing the generalizability of these findings. Within the domain of problem solving, several theories of cognitive style have proposed a bipolar distinction "between rule bound strategies and exploratory search strategies as main characteristics (Kolb, 1976; Kaufmann, 1979, 1983; Kirton, 1989)" (Maxtinsen, 1994, p, 83). Kaufmann's (A-E)

Assimilator-Explorer is one such theory, another is Kizton's (1976) Adaption-Innovation Inventory (KAU theory which is also noted for distinctive and contrasting a bipolar preference styles termed as adaptor and innovator.

Empirical Review

Effect of Context on Problem solving

Context is a powerful survival tool; that can influence human ability of problem solving, but it depends on the environment context of learning. Problem solving is better if the environment of original learning that is the same environment is being used for the study. This is unlikely to be due to disruption, and one can be reasonably confident that it is a truly context-dependent phenomenon.

Lovertt and Anderson (1996) studied history of past context and current context in problem solving. This study makes use of 450 participants, 284 male and 166 female. The researchers presented the two groups to demonstrate the solvers use at least use at two sources of information from their past context and information from current context of the problem solving. These two effects respectively represent the learning and performance process that influence problem solving. The result obtained showed that problems can be solved better in past context than tin current context.

Godden and Baddley (1975) investigated the phenomenon of context-dependent memory (CDM) in two natural environments using 18 solvers (13 males and 5 females). The participants were asked to learn a list of 40 words both on land and under-water, and subsequently recalled either on land (dry) or under water (wet). Each participant performed under all 4 possible conditions: DD (Learn dry, Recall Dry); DW (Learn dry, recall wet); WW and WD should the phenomenon of context-dependent memory exist under these conditions, the experimenters hypothesized that performance where learning and recall took place in the same environment (DD and WW). Result showed that, for learning in environment D, recall in environment D (mean = 13.5) was better than recall in environment W (mean = 8.6), whole learning in environment W recall in environment W (mean = 11.4) was better than recall in environment D (mean = 8.4). There was no significant difference in recall between condition DD and WW; between conditions DW and WD. The study is clearly in line with the context-dependent memory hypothesis what was learned under water was best recalled in solving problem.

Ericson and Kintsch (2004) tested whether context will have a significant effects on problem solving, (200) undergraduates students (128 males and 72 females with a mean age of 96.4 years) participated in the experiment. They were to be assigned to different context condition that is (far and near) environment. The participants were drawn from the population f law students of Harvard University. The study examined the difference between far and near context in problem solving using mathematics set. Result showed that those students who solved mathematics sect in near context environment performed better than those students far environment in solving mathematical problem.

Context manipulation might have some important and practical application to education as shown by Smith, Glenberg, and Bjork (1978). These researchers studied the relationship between environmental context and memory as measured by recall. Some college volunteers were made to study lists of paired associate words under two different environmental conditions to learn the list in a large, windowless room located off campus, with the list presented visually and to learn the list in a small room on campus where the list were presented on a tape recorder. Participants were given one of the paired associates and were asked to recall its make after a 24-hour retention interval.

The result was impressive when participants were tested in the same room in which they had learned the list they recalled 59% of the paired-associate word or mathematics. When they were tested in the different room in solving the problem, their recall performance dropped to 46%. This study makes an important point: if the participants had been graded their drop-off would have meant a difference between pass and failure. Smith and Colleagues (1978) cautioned that if teachers are serious about getting optimal performance from their students, their rests and finals should always be given in the same classroom in which the class meeting took place.

Lovett and Anderson (1996) studied history of success and current context in problem solving: combined influences on operator selection. The researchers presented three experiments that demonstrate that solvers use at least two sources of information to make operator selections in the building sticks task (BST): information from their past history of using the operators and information from the current context of the problem. Specifically, problem solvers are more likely to use an operator the more successful it has been in the past and the closer it takes the current state to the goal state. These two effects, respectively, represent the learning and performance processes that influence solversô operator selections. A computational model of BST problem solving, developed within the ACT-R theory (Anderson, 1993), provides the unifying framework in which both types of processes can be integrated to predict solversô selection tendencies. Hippel, (1994) examined sticky informationò and the locus of problem solving: implications for innovation. Often the information used in technical problem solving is costly to acquire, transfer, and use in a new locationð is, in our terms, ñsticky.ò Researchers find, first, that when sticky information needed by problem solvers is held at one site only, problem solving will be carried out at that locus, other things being equal. Second, when more than one locus of sticky information is called upon by problem solvers, the locus of problem solving may iterate among these sites as problem solving proceeds. When the costs of such iteration are high, then, third, problems that draw upon multiple sites of sticky information will sometimes be ñtask partitionedò into sub problems that each draw on only one such locus, and/or, fourth, investments will be made to reduce the stickiness of information at some locations. Brezillon (1999) investigated context in problem solving: a survey. The study presents a survey of the literature dealing directly and explicitly with context whatever the domain. This makes it possible for the researchers to have a clear view of context in AI. One of the conclusions of the survey is to point out the existence of different types of context in areas such as the representation of knowledge in a computer system, the reasoning that the system carries out using the knowledge, and the interaction the system has with people

Kokinov and Yoveva (2004) looked at context effects on problem solving. Context effects on problem solving demonstrated so far in the literature are the result of systematic manipulation of some supposedly irrelevant to the solution elements of the problem description. The main purpose of the current paper is to avoid this limitation and to study the context effects (if any) caused by such accidental elements from the problem solver's environment and in this way to test the predictions made by the dynamic theory of context and its implementation in the DUAL cognitive architecture. Two experiments have been performed. In Experiment I the entities whose influence is being tested are part of the illustrations accompanying the target problem descriptions and therefore they belong to the core of the context, while in Experiment II the tested entities are part of the illustrations accompanying other problems' descriptions, they are accidental with respect to the target problem and therefore they possibly belong to the periphery of the context (if a context effect could be demonstrated at all). The results demonstrate both near and far context effects on problem solving caused by core (Experiment I) and peripheral elements (Experiment II) of the perception-induced context, respectively.

Hallgrimsson and Henry, (2012) in a study titled it's all about context: problem solving through contextual model making and sketching. The authors examine how teaching the traditional skills of model making and sketching should be aligned to a modern design curriculum. The notion of skill and mastery as well the underlying reasons for why these need to change in focus from an overriding emphasis of technique towards an emphasis on exploration, testing, communication and verification is explained from the vantage point of several contexts. With the rapid advances in digital prototyping and other forms of digital visualization, design educators must not shift their emphasis merely towards a myopic focus on these technologies, but rather towards a better synthetic workflow that encourages re-framing and innovative thought less influenced by stereotyping and more motivated by new user-centered solutions. This will require a better integration of digital and analog tools so that the thinking process remains pragmatic

Liu, Ke and Wu (2012) studied context-based knowledge support for problem-solving by rule-inference and case-based reasoning. Problem-solving is an important process that enables corporations to create competitive business advantages. Traditionally, case-based reasoning techniques have been widely used to help workers solve problems. However, conventional approaches focus on identifying similar problems without exploring relevant context of problem situations. Situation features are generally occurred according to the context characteristics of problem. Workers need to use knowledge inferred from relevant context information and previous problem-solving experience to clarify the causes and take appropriate action effectively. The discovered patterns identify frequent associations between context information and situation features, and therefore can be used to infer more situation features. By considering the inferred situation features, case-based reasoning can then be employed to identify similar situations effectively. Moreover, we employ information retrieval techniques to extract context-based situation profiles to model workerspsila information needs when handling problem situations in certain context. Effective knowledge support can thus be facilitated by psroviding workers with situation-relevant information based on the profiles.

Effect of Cognitive style on Problem solving

Cognitive psychologists have acknowledged a difference between field-dependent and field independent cognitive style. Cantario and Mason (2000) studied that in almost all situations, students performances are better on field independent test that on problem solving. Most experimental studies indicate that field-independent is easier than field-dependent. (e.g. Mayer & Wiltrock, 1996). The most widely used method of assessing knowledge of any psychological construct asks participants to choose from a list of correct and distracter items. The task is one of problem solving. Another method of assessing participantsô knowledge has been the use of open-ended question or other types of problem solving. Although these methods have been applied in different settings; results suggest that the two methods yield very different results.

Studies evaluating secondary school mathematics test of simultaneous equation and quadratic equation factors associated with problem solving varied in question format used. Squaire and Knowlton (1993) observed that those using many methods or formula from field-independent cognitive style have tended to find higher levels of knowledge than those using one method from field-dependent in solving the problem. These researchers studied a sample of 450 participants to quantify the effect of prompting on knowledge of mathematical problem solving of simultaneous equation and quadratic equation. The students were randomly selected and assigned to difference examination hall, using SSIA and SSIB age range of 14-16 year. However 5 minutes were given to the participants to solve the simultaneous and quadratic equation analysis of their results demonstrated significantly higher knowledge of field-independent in problem solving when compared with those field-dependent, therefore a significant effect exist.

Similarly, cognitive style scores for both field-independent and field-dependent were better, compared to their problem solving. Hommel, Colzato, Fischer and Christofel (2011) reported that field-independent does not differ significantly from field-dependent in solving mathematical problem, but that the field-independent is substantially below that of field-dependent (Nielsen, Pickiech & Somonton, 2008) explored whether recall is disproportionately disrupted. Those of field-dependent (with a man age of 64.0 years and an average of 8.5 years of education) were compared with those field-independent (with a mean age of 49.8 years and average of 7.3 years of education).

The study equated field-independent with 10 of study time and field-dependents of participants with 0.5. Results showed that field-independent was superior to field-dependent cognitive style in solving mathematical problems, even when no differences were found in problem solving. This result suggests that field-independent participants reflects not a general depression of thinking but rather a selective not disruption of an aspects of thinking contrary to successful problem solving. But more importantly, even when the scores of the field-dependent for the categorized list were compared, the field-dependent recognized in average of 6.1 words as against the average of 2.5 words which they solved.

Capitanio and Mason (2000) studied Cognitive style: problem solving by rhesus macaques (Macaca mulatta) reared with living or inanimate substitute mothers. Cognitive style, reflected in the generation of novel solutions and the use of identifiable response strategies in problem-solving situations, was contrasted in rhesus monkeys (Macaca mulatta) reared individually with either canine companions or inanimate surrogate mothers. Four experiments were conducted over a 5-year period, examining problem solving in relatively unstructured as well as more formal situations. Results indicated that whereas the 2 rearing groups did not differ on most measures of performance, consistent response strategies were identified for the dog-raised monkeys. The results were compared with previously published data from the same monkeys demonstrating rearing group differences in abilities to engage in complex social interaction. The animate nature of the early rearing environment may facilitate-the development of a cognitive style that influences problem-solving abilities in both the social and nonsocial realms.

Margaret (1982) examined consistent differences in cognitive styles shown for qualitative biological problem-solving. Three qualitative, unfamiliar problems were designed to explore differences in cognitive styles in a biological context, and were given to 48 first-year tertiary students. Two components of cognitive style were identified. The first was the students' perception of a problem, categorized into analytic, holist and versatile. The second was the ability of students to integrate a particular problem with their existing knowledge, categorized as high and low level. Overall 42 per cent used a singular analytic style of perception; conversely 8 per cent explained all tasks in a purely holist style, and 50 per cent showed varying ability to use both styles of perception in different problems. When the students' results were individually compared for these two problems, it was found that only four students (8 per cent) changed their style of perception between two similar problems. Overall, the percentages of female and male students using a purely analytic style were approximately equal. A higher percentage of students showed a óhighô level of integration for the familiar Graph problem than for the unfamiliar Immunity problem. This suggests that the ability to integrate relates more to the content of the task, than does style of perception.

Happel (1994) in a study that examined cognitive style and order of problem solving effect in puzzle box, postulated that cognitive style (field dependence, independence) did not show any systematic differential association with ear preference. Accuracy in contrast varied significantly as a function of cognitive style. Field independent subject were more accurate than their field dependent counterparts; variability apparent group differences under problem solving. The order of problem factor was without effect here. No differences emerged between males and females in terms of ear preference, accuracy or cognitive style.

Linda and Davis (1978) examined study techniques and cognitive styles: their effect on problem solving field ï independent and field dependent college students studied a 1252 word article under a preferred or non preferred study condition (read only, erred or non preferred study condition (read only, underline or note taking). Half of the students reviewed the material prior an examination and half did not. Result indicated that both field-independent and field dependent subjects generally produced best recognition scores when they used a non preferred technique and reviewed. Both note takers and underliners produced significantly better problem solving scores than readers only.

Chan (1996) looked at cognitive misfit of problem-solving style at work: a facet of person-organization fit. Relationships among cognitive misfit, job performance, and actual individual turnover after 3 years were examined in a sample of 253 engineers in either a Staff engineering function or a Research and Development (R&D) engineering function. The staff function and the R&D function corresponded to a work context predominant in adaptive-style demands and a work context predominant in innovative-style demands, respectively. Results from logistic regression analyses showed that cognitive misfit was uncorrelated with job performance, but provided significant and substantial incremental validity in predicting actual turnover over the predictability provided by performance.

Kaufmann, (1979) investigated the explorer and the assimilator: a cognitive style distinction and its potential implications for innovative problem solving. A novel cognitive style distinction is introduced: The Assimilator is presumed to be guided by a Rational (R) strategy which is seen essentially to consist in stretching established principles as far as possible in coping with novel tasks. In contrast, the Explorer spontaneously seeks novel solution alternatives, even in problem situations that are easily mastered through the application of a standard principle. The assets and liabilities of these different approaches in problem solving are discussed, with special reference to innovation. It is hypothesized that the Explorer in this respect is in a more profitable position. A modified version of Luchinõs Einstellung-situation provided the empirical basis for distinguishing between Assimilators and Explorers and allowed for a validation of the theoretical assumptions. The results clearly supported the hypotheses of the experiment.

Messick (1984) examines characteristic features of cognitive styles and the various ways in which styles differ from one another and from intellective abilities. These distinctions are integrated into a unified framework that serves to define cognitive styles in contrast not only to abilities but to other types of stylistic variables. Educational implications of cognitive styles are discussed in terms of six main rubrics: improving instructional methods, enriching teacher behavior and conceptions, enhancing student learning and thinking strategies, expanding guidance and vocational decision making, broadening educational goals and outcomes, and tuning the stylistic demands of educational environments. Reasons why cognitive styles should have educational impact are addressed as well as reasons why such educational benefits are difficult to realize.

Sevenants, Verschueren and Schaeken (2008) studied the contribution of cognitive style, cognitive abilities and expertise to the solving of complex problems. A óNeed for Cognitionô (NfC) questionnaire, a cognitive abilities test and five complex problems were presented to a group of experts (Experiment 1) and to a group of novices (Experiment 2). Generally, experts performed better on the complex problems than did novices. Experts low in cognitive ability solved complex problems better than those high in cognitive ability; in addition, experts high on NfC solved complex problems better than those low on

NfC. Furthermore, experts low on cognitive ability and low on NfC did best. Within the group of novices, no effect of cognitive ability and NfC on the complex problems was observed.

Arroyo, Woolf and Beal (2003) looked at a study on addressing cognitive differences and gender during problem solving. This research evaluated the impact of supplementing user models with additional data about cognitive features of the student. Supplemental data included individual differences variables such as: developmental stage of the learner (Piagetian), spatial ability, math-facts-retrieval and gender. These differences were applied along with multimedia and customization in two intelligent tutoring systems, one for arithmetic and one for geometry. The research resulted in the general conclusion that enhancing user models with detailed information about cognitive ability led to improved response to instruction. This is especially important to consider for domains for which there are well-established group differences, such as gender differences in mathematics.

Influence of Gender on Problem solving

Gender-related differences in problem solving abilities have generated a great deal of controversy. When and why they appear, their magnitude, and their consequences are hot issues in contemporary psychology (Murphy & Ross, 1987). It is arguable that males and females have different kinds of problem solving abilities and that the kinds of items appearing in problem solving tests happen to favour males. Heather, Casper and Camp (1995) studied gender differences in general knowledge, and the degree to which these are a function of difference in problem solving ability. The sample comprised 1200 undergraduates (625 male and 575 female) who ranged in age from 18 ï 45 years. (female. Mean age = 25.5.years, male mean age = 336.5 years) participants were measured on a short from of the General Knowledge Test (GRT) Result showed that males score more highly than females on problem solving of General Science (- 45) and Government, where as females scores more highly on medicine (.25) and fashion (.09). Although females did better than was predicted, the magnitude of the effect of gender on problem solving of general knowledge provides strong evidence that male have a larger advantage on problem solving of general knowledge.

Blanchard-fields, Camp, and Cameron (1995) investigated qualitative differences in problem-solving for situations varying in emotional salience were examined among (male and female) participants wrote essays on how each of 15 problem situations should be resolved. There were minimal age differences for problem-solving strategies, with all age groups using this strategy. The most age differences for problem solving strategy were highly dependent on the degree to which the situation was emotionally salient. All individuals were more likely to use an avoidant-denial strategy in how emotionally salient situations and passive-dependent and cognitive-analysis strategies in high emotionally salient situations. The results showed that male groups used both passive-dependent and avoidant-denial strategies more than female groups. Problem-focused strategies were used least in high emotionally salient situations. The results showed that male groups used both passive-dependent and avoidant-denial strategies more than female groups. Problem-focused strategies were used least in high emotionally salient situations. Implications of findings are discussed from male developmental perspective. The study population was 260 participants (130 male and 130 female) that equal distributed of participants.

Amponsah and Krekling (1997) stated that patterns and magnitudes of sex differences spatial abilities were similar across culture. The researchers examined similarities and differences in the patterns of gender differences in two cultures. The cross-cultural consistency of gender differences on visual-spatial ability tests was compared. Four visual spatial ability tests (water level, surface development, PMA space, and

Vandenberg-Kuse), were used to collect data from 197 University students in Ghana (79 females, 118 males) and 220 University students in Norway (150 females, 70 males). Their mean age was 26.5 years however the Ghanaians participants were slightly older than the Norwegian participants. Except for the surface development test on which no gender difference appeared in either sample, males performed significant better than females in both samples.

Some researchers have argued that perhaps many findings suggesting male advantage on cognitive and spatial abilities may not have adopted sensitive measures after (Cox and Waters, 1986). The reason stems from the fact that many of these studies ignore the use of a general development framework, which is necessary to interpret these results correctly. Cox and Water (1986) investigated gender differences in the use of organization strategies in free recall with categorizable and unrelated word list across age. In experiment 1, the researchers examined the use of organization strategies with categorizable word list on 1st, 3rd, and 5th grade children. On each grade level, there were 24 females and 24 males, whose ages differed according to their grade level. Each grade level received different list length, with consequent differences in category structure. Separate analysis of organization and organization-recall relationships were conducted for each grade. In experiment 2, the use of organization strategies was examine with unrelated word list across two processing conditions. Only the 3rd and 5th grade children participated in this experiment because organization with unrelated word list develops later than with the categorizable word lists.

Result of experiment 1, indicated that only females demonstrate significant levels of organization in 1st grade, and then only under the more favourable semantic processing conditions. In the 3rd grade, both males and females show significant levels of organization, but only under semantic orienting task instructions. In the 5th grade, females generalize the use of organization to the less favourable standard processing conditions. Result from experiment 2, showed no use of organization for males or females in 3rd grade with unrelated word lists, and significant levels of organization for females in 5th grade, but only under more favourable processing condition. Gender differences were not only pronounced across the ages tested, but were consistent with the principle of strategy development in general, with males showing a developmental lag in the use of organization strategies across age. The importance of context is clear in the present results, gender differences occur only under certain circumstances. Females are more sophisticated strategy users only some of the time. Female semantic development is more advanced, and is expected that females should initiate the use of elaborative strategies sooner than males.

Other studies, for example Hyde and Linn (1988), contend that beyond the global statement that females have superior verbal ability to males, there are little knowledge about the nature of the gender differences in verbal ability, either in terms of the types of abilities showing gender differences or the development timing of possible differences. Hyde and Linn analyzed several studies in which the detection of gender differences was of primary interest in the study. The meta-analysis surveyed 165 studies that represent the testing of 1,418,899 participants. The analysis was designed to provide answers to five questions: what is the magnitude of gender differences in verbal ability?; is the magnitude of gender differences in verbal ability declining?; are gender differences in verbal ability uniform across various measures of verbal ability, such as vocabulary, analogies, and essay writing, or does the magnitude of the fender difference vary on these task, perhaps being close to zero on some and large on others?; developmentally, at what ages do gender differences appear or disappear, and on what task?; and are there gender differences in certain aspects of verbal information processing that produce the gender differences in tested verbal abilities?

The result of the meta-analysis showed that the weighted mean effect size is +0.11; indicating a slight female superiority in performance. Analyses of effect sizes for different measures of verbal ability showed almost all to be small in magnitude. The researchers argued on the straight of their finding that gender differences in verbal ability is so small that it can effectively be considered to be zero. More detailed analyses of various types of verbal ability (vocabulary, reading comprehension, and analogies) similarly yielded no evidence of a substantial gender differences.

Nagae (1985) align with the conclusions of the meta-analysis, he studied the influence of handedness and sex differences in processing manner of verbal and spatial information. Left and right-handed males (n=24) and females (n=24) were given the task of viewing sets of six or eight letters in a 5 x 5 matrix and recalling either: the letter, the positions of the letter, or both the letters and their positions. Results of the study showed that there was no differential recall of letters and positions according to sex. The researcher concluded that handedness in general; appear to be a better predictor of cognitive abilities than dos gender.

Similar result was reached by Lynch and Cicchetti (1998), they examined the links among trauma, representational models of caregivers, and childrenõs memory for motherï relevant information. Lynch and Cicchetti used an incidental recall task in a sample of maltreat (n=71) and non-maltreated (n=120) children between the ages of 8 and 13 years. The study employed a two-task design to provide information about the nature of childrenõs mental representation of maternal caregivers and childrenõs encoding of memory for mother referent attribute words. The researchers performed a series of t-test to examine the effect of childrenõs gender on the primary variables of interest. Although boys reported higher levels of psychological proximity seeking with respect to their maternal care-givers (mean=2.74) than did girls (mean=2.39), there were no other effects of gender.

Their previous study (Ding & Harskamp, 2006) showed that in collaborative learning in physics, female studentsô learning achievement was sensitive to their partner gender while this was not the case for male students. Moreover, the mixed-gender collaboration seemed to disadvantage female students. Gendered communication styles may be one of the reasons behind this. When female students solve the problems with a male partner, they tend to ask questions or paraphrase problem information. Their male partners, on the other hand, are more likely to provide help and offer suggestions. In mixed-gender collaboration, a great degree of uncertainty can be found among female students. However, females in female female dyads are not so submissive. They put forward their ideas freely and actively develop problem solving strategies. Collaboration in female-female dyads seems to be better balanced than it is in mixed-gender dyads.

In addition to gendered communication styles, some research has suggested that females perform better than males on verbal-ability tests, while males outperform females on tests of visual-spatial ability (Kellogg, 1995). This finding leads us to the question of whether female and male students use different ways to represent knowledge when solving a physics problem. However, for the second research question, whether studentsô visual and verbal representations are influenced by their partnerôs gender in dyadic physics problem-solving, it is still difficult to hypothesize. So far, very few attempts have been made to explore the gender difference in this regard. Do females tend to convey the problem information and describe the solution verbally, while males are more likely to use pictures or charts to illustrate the problem components and the relationship between the variables? Is their representation mode affected by their partnerôs gender? Finding answers to these questions is essential for unraveling studentsô cognitive activities in collaborative problem solving.

The study was conducted in a high school in Shanghai, China. Fifty tenth-grade students (26 females and 24 males) with an average age of 16 participated in the study. In total, there were twenty-five dyads. Students were randomly selected from two classes taught by the same physics teacher. Students participating in the study represented various socioeconomic backgrounds. This high school ranks among the five best schools in Shanghai. Therefore, students have a rather good basic knowledge of physics. The ultimate goal of education is to prepare students to work effectively in various social situations which are not only limited to single-gender groups (Speck, 2003). With this goal in mind, students were randomly paired. There were twelve mixed-gender dyads, seven female-female dyads and seven male-male dyads. For research purpose, we defined four conditions, namely, females in mixed-gender dyads (F in MG, N=12), males in mixed-gender. Randomized group design with a pre- and a posttest was used. The treatment took weeks. First, the teacher gave two introductory lessons on Newtonôs Second Law for 45 minutes each. Then, a 50-minute pretest was administered to students. This consisted around four of five moderately structured problems about Newtonian mechanics. Then students were given ñpre-flightò training in how to use the communication log-sheets and answer sheets. The study consisted of four 45-minute sessions. Students were all exposed to the same number of experimental hours and the same instructional materials. Twenty-five dyads of students were spread over different classrooms in order to have ample room for collaboration without disturbing each other. In each classroom there was a teacher or a research assistant who oversaw the experiment.

Physics experiences the largest gender gap, and males tend to outscore female students (Sadker & Sadker, 1994). Studies of elementary and secondary education have revealed that this divergence originates at the high-school level (Lorenzo,Crouch & Mazur, 2006). Collaborative problem solving seems to be a promising heuristic approach.

In collaborative learning two or more students work together in order to accomplish a given task and so achieve a joint product (Dillenbourg, 1999). Students have to listen to their partnersô perspectives and negotiate with each other in order to arrive at a mutual understanding. They elaborate on their partnersô ideas, elicit cognitively oriented self-explanations and jointly make sense of the task (Nastasi & Clements, 1992). Interpersonal interaction exposes participants to different perspectives (Miyake, 2006) and makes difficulties in the solving of problems clearer for students while making them more open to interactive problem solving (Heller,1992). However, the relationship between gender and collaborative learning is a complex issue (Ingram & Parker, 2002; Li, 2002; Ding & Harskamp, 2006). The current study has suggested that the learning achievement of female students is sensitive to their partnerǿs gender. Female students working in the single gender dyads surpass their counterparts in the mixed-gender dyads. But this is not the case for male students. Mixed-gender dyadic collaboration seems to disadvantage only female students.

According to Anderson (1995), the way in which information is represented can affect the way it is processed. In order to gain an insight into studentsô cognitive activities, we examined their cognitive representations during collaboration. We focused on two methods of knowledge representation: visual and verbal representations. Both are of vital importance in problem solving (Presmeg, 1985). As for the first research question, whether there was a gender difference in knowledge representation in collaborative problem solving, our study has suggested that female and male students did have different ways of representing knowledge. Female students preferred using verbal representations to convey problem information while males were more adept at visualizing problem components and mapping the solving strategies. Our second research question concerned whether studentsô representation modes were sensitive to their partnerǿs gender. It was found that neither female nor male studentsô representation modes were affected by their partnerôs gender. It can be extrapolated that there may not be a great problem for single-gender collaborative problem solving because both interlocutors tend to use the same representational way of discussing the problem information and working out a solution. However, this finding made us reflect further on the mixed-gender collaboration. What kinds of problems may appear when female and male students work on a physics problem together but use different ways to represent the problem variables and relationships between problem components. They chose a communication log sheet of a mixed-gender dyad to gain an insight into this issue.

Wang (2005) in a study that developed and empirically tested an integrated model that examined the relationships between sex-role orientations and the two conceptually related coping behaviours, namely, response styles and social problem-solving, using structural equation modelling. A total of 181 (129 females and 52 males) undergraduate students from a large public university in the northeast United States completed the Bem-Sex Role Inventory, the Response Style Questionnaire and the Rational Problem Solving scale of the Social Problem-Solving Inventory-Revised. Results showed that masculinity was related to social problem-solving. Sex-role orientations were not related to response styles. Both ruminative response style and distractive response style were positively related to rational problem-solving.

Barbieri and Light (1992) studied interaction, gender, and performance on a computer-based problem solving task. This paper reports a study in which 66 eleven and twelve year old children worked in boy-boy, girl-boy or girl-girl pairs on a novel problem-solving task on a computer. All were post-tested a week later individually, using a slight variant of the same task. Interaction in the pairs was analyzed from videotape in terms of verbally explicit planning, negotiation, etc. These interaction variables were examined in relation to the levels of success attained both as a pair and at individual post-test. Significant though fairly modest levels of correlation were obtained. Analysis also focussed on the issue of gender. The different gender pairings did produce different patterns of interaction (with, for example, marked dominance patterns in the mixed pairs), but the substantial advantage of boys over girls in terms of final performance turned out to be largely independent both of pair type and of the verbal interactional measures used.

Gallagher and De Lisi (1994) Examined whether male and female students of high mathematical ability use different solution strategies on math problems that had previously yielded gender differences in correct responding. Structured interviews were conducted with high school students who had scored at least 670 on the math portion of the Scholastic Aptitude Test (SAT-M). Eight types of solution strategies could be further dichotomized as conventional or unconventional in approach. Female students were more likely than male students to use conventional strategies. SAT-M scores were correlated with positive attitudes (confidence and persistence) toward math: use of conventional strategies was correlated with negative attitudes (dislike, nonrelevance) toward math. Findings may help to explain patterns of gender differences on SAT-M problems among high-ability students in which female students outperform male students on conventional problems and male students outperform female students on unconventional problems.

Murphy, and Ross (1987) studied gender differences in the social problem-solving performance of adolescents. Compared to other cognitive measures, social problem solving has received little attention in research on gender differences. In the present study, the Means-Ends Problem-Solving Procedure and the Personal Attributes Questionnaire (PAQ) were administered to 207 adolescents to examine social problem-solving skills as a function of subject gender, PAQ type, and gender of protagonist. Hypotheses were that superior problem solving would occur (a) for androgynous and masculine PAQ types and

(b) when subject gender and/or PAQ type corresponded with protagonist gender. Results failed to corroborate these patterns, but indicated a clear overall advantage for females over males. A follow-up multiple-regression analysis showed this effect to be stable after controlling for English level. In a supplementary analysis, PAQ breakdowns were compared for the present sample and for one tested in a different region seven years earlier. Overall, the research findings imply that fewer adolescents today are likely to identify with traditional feminine roles, and that sex-related personality traits have, in general, a relatively limited impact on social problem-solving skills.

Gallagher, and Cahalan (2000) examined gender differences in advanced mathematical problem solving. Strategy flexibility in mathematical problem solving was investigated. In Studies 1 and 2, high school juniors and seniors solved Scholastic Assessment Testï Mathematics (SAT-M) problems classified as conventional or unconventional. Algorithmic solution strategies were studentsô default choice for both types of problems across conditions that manipulated item format and solution time. Use of intuitive strategies on unconventional problems was evident only for high-ability students. Male students were more likely than female students to successfully match strategies to problem characteristics. In Study 3, a revised taxonomy of problems based on cognitive solution demands was predictive of gender differences on Graduate Record Examinationï Quantitative (GRE-Q) items. Men outperformed women overall, but the difference was greater on items requiring spatial skills, shortcuts, or multiple solution paths than on problems requiring verbal skills or mastery of classroom-based content. Results suggest that strategy flexibility is a source of gender differences in mathematical ability assessed by SAT-M and GRE-Q problem solving.

Zhu (2007) looked into gender differences in mathematical problem solving patterns: a review of literature. A large body of literature reports that there are gender differences in mathematical problem solving favouring males. Strategy use, as a reflection of different patterns in mathematical problem solving between genders, is found to be related to cognitive abilities, together with psychological characteristics and mediated by experience and education. Many complex variables including biological, psychological and environmental variables are revealed to contribute to gender differences in mathematical problem solving in some specific areas. This article suggests that the combined influence of all affective variables may account for the gender differences in mathematical problem solving patterns.

Maydeu-Olivares and Kant (1998) examined age and gender differences in social problem-solving ability. In general, the results suggest that social problem-solving ability increases from young adulthood (ages 17ï20) to middle-age (ages 40ï55) and then decreases in older age (ages 60ï80). Specifically, compared to younger adults, middle-aged individuals scored higher on positive problem orientation and rational problem solving, and lower on negative problem orientation, impulsivity/carelessness style, and avoidance style. Compared to older adults, middle-aged individuals scored higher on positive problem orientation and rational problem solving. Some age differences were specific to one gender. Across age groups, gender differences were found on positive problem orientation and negative problem orientation. Within the young adult group, gender differences were also found on impulsivity/carelessness style

Hyde (1990) published a groundbreaking meta-analysis that compiled data from 100 different studies of math performance. Synthesizing data collected on more than 3 million participants between 1967 and 1987, the researchers found no large overall differences between boys and girls in math performance. Girls were slightly better at computation in elementary and middle school. In high school, boys showed a slight edge in problem solving, possibly because they took more science classes that emphasized those skills. But boys and girls understood math concepts equally well and any gender differences actually narrowed over the years, belying the notion of a fixed or biological differentiating factor.

Hyde and colleagues (1988) for verbal ability reported that data from 165 studies revealed a female advantage so slight as to be meaningless, despite previous assertions that girls are more verbally adept. What's more, the authors found no evidence of substantial gender differences in any component of verbal processing.

Spelke, (2005) in a study on Sex differences in intrinsic aptitude for mathematics and science?: A critical review.reviewed 111 studies and concluded that gender differences in math and science ability have a genetic basis in cognitive systems that emerge in early childhood. Nevertheless, the studies suggested that men and women on the whole possess an equal aptitude for math and science. In fact, boy and girl infants were found to perform equally well as young as 6 months on tasks that underlie mathematics abilities.

For collaborative problem solving in physics there are normally two types of cognitive activities that students engage in: constructing a graph to illustrate variables or their problem-solving strategy (visual representation), and verbally exchanging problem information (verbal representation). The aim of this study was to explore gender differences in terms of the way that students represent their knowledge when solving a physics problem. The study also investigated whether studentsô representation modes were sensitive to their partnerôs gender. This four-week-long empirical study was conducted in a high school in Shanghai, and included one-week of regular classroom instruction, a ñpreflightò training session, a pretest, a three-week treatment and a posttest. The subjects of this study were 26 female and 24 male Chinese tenth graders. During the study students were randomly paired to solve physics problems together. They were only allowed to use the log-sheets in order to communicate. The analyses consisted of studentsô pre- and posttest scores, and their written messages on the log-sheets. The findings suggested that the contributions made during the collaboration were represented by females and males. Female students were more likely to use verbal messages to convey information, while male students tended to use visual representations. Studentsô representation modes, however, were not affected by their partnerös gender. These findings add valuable new facets to the body of ongoing research into collaborative learning and problem solving learning in physics. In closing, the educational implications and some suggestions for future research will also be discussed promotes their understanding of scientific concepts and theories Hyde et al.ös (1990) meta-analysis of 100 studies suggested that gender differences in mathematics performance were small but gender differences in mathematical problem solving with lower performance of women existed in high school and in college. Many studies also pointed out the existing of gender differences in mathematical problem solving (Linn & Petersen, 2000). Many factors such as cognitive abilities, speed of processing information; learning styles, socialisation were suggested to have contributions to gender difference in mathematical problem solving (for example, Duff, Gunther, & Walters 1997). Based on these findings, we may assume that females and males have different patterns of mathematical problem solving. Since many mathematical problems on standardised tests are multi-step and require some systematic approach, students could arrive at a correct solution by choosing and combining a set of appropriate strategies. Strategy flexibility is important for successful performance on standardised tests such as the SAT-M (Gallagher et al, 2000). Only focusing on test sores might not reveal gender differences in problem solving patterns, investigating gender differences in strategy use might shed some light on researching gender patterns of mathematical problem solving. In this section I include some relevant studies that posited some hypotheses on studentsô strategy use from different perspectives, to try to compare different patterns of mathematical problem solving between female and male students. Some research studies have reported gender differences in strategy use among elementary school students (Carr & Jessup, 1997)

Frank, and Levi (1998). First-grade girls were more likely to use a manipulative strategy and first-grade boys were more likely to use a retrieval strategy to solve mathematics problems (Carr and Jessup, 1997). Carr and Davis (2001) found that during the free-choice session of their study, girls and boys showed different preferences for strategy use to achieve the solution, which replicated the earlier findings of Carr and Jessup (1997); while during the game condition that constrained the types of strategies children used, boys showed the same ability as girls to use a manipulative strategy to calculate solutions, but girls were not as able as boys in the use of a retrieval strategy. Fennema et al. (1998) suggested girls tended to use more concrete strategies and boys tended to use more abstract strategies and that elementary school boys tended to be more flexible in employing strategies on extension problems than elementary school girls. Their study also found girls chose to use more standard algorithms than boys at the end of Grade 3. However, there were no gender differences in the group whose members had used *invented algorithms*2 in the earlier grades. Gender differences in strategy use were evident among secondary school students (Gallagher and Delisiӧs, 1994; Gallagher et al, 2000). Tartreӧs (1993) suggested that high school boys tended use a ñcomplementò (p.52) strategy to solve problems involving three-dimensional figure. High school girls tried to use more writing to solve problems requiring a written strategy. Studies by Gallagher and her collaborators (Gallagher and Delisi, 1994; Gallagher et al, 2000) reported that among high school high-ability students there was no overall gender difference in the numbers of correctly answered items on the SAT, but under different situations, females and males approached mathematical problems by using different strategies. Gender differences were evident in successful patterns and in strategy use on conventional and unconventional problemsé female students were more likely than male students to correctly solve ñconventionalò 3 problems (by) using algorithmic 2 *Invented algorithm* is used by Fennema et al (1998) to identify strategies that involved abstract procedures children construct to solve multi-digit problems. It is distinct from those strategies with automatized quality. 3 Gallagher (1990, 1992) classified many of the problems on the SAT-M into two categories: conventional problems are those problems that can be solved by familiar algorithms, which are normally textbook-problems; 190 Gender differences in mathematical problem solving patterns: A review of literature strategies; male students were more likely than female students to correctly solveñunconventionalò problems (by) using logical estimation and insight. (Gallagher et al.,2000, p.167)

Researchers have made a point that there is a relationship between the levels of studentŝ abilities and strategy choice and efficiency (Lohman and Kyllonen; Kyllonen, Lohman and Snow; Kyllonen, Lohman and Woltz; Wendt and Risberg, in Burin et al., 2000). Higher ability students tended to solve problems by using more spatial processes, while the others tried to solve problems in a more analytical way. Tartre (1990, 1993) suggested that females with high spatial orientation (SO) skills were assumed more than high SO males to be able to integrate spatial and analytic or language skills to successful problem solution. Tartre also found that low SO males were found to be able to use the verbal hint effectively to help solving problems; but low SO females needed help more often and did not always use it successfully. It can be concluded from Tartreŝ study that the gender differences in strategy use during mathematical problems solving fall into two classes: (a) on one hand, gender difference within groups with high-spatial level skills arose through the ability to integrate many problem-solving strategies, with which females did better than males; (b) on the other hand, gender difference within groups with low-spatial level skill arose from the ability to use other skills to compensate, in which males outperformed females. The discrepancy between spatial and verbal abilities also affected both femalesô and malesô strategy use. Since many mathematical problems could be solved either by a spatial approach or by a verbal approach or by both of them, the discrepancy between spatial and verbal abilities would influence how students approached mathematical solutions (Krutetskii, 1976). For example, a student with high spatial ability and low verbal ability might try to use more spatial strategies to solve mathematical problems, while students high or low in both abilities might be more variable in strategy use (Battista, 1990). Therefore, if male and female students were discrepant in strengths and weaknesses of their spatial and verbal abilities, they would solve mathematical problem differently. A different ratio in the use of spatial to verbal skills (Maccoby and Jacklin, 1974), which in turn would influence studentsô problem solving abilities and strategies (Battista,1990), might create different patterns of mathematical problem solving between the two genders. Fennema and Tartre (1985) conducted a three-year longitudinal study among middle school students (Grade 6 to Grade 8) in order to examine how students with discrepant spatial visualisation (SV) and verbal skill solved mathematical problems. The samples were divided into four groups: high SV/ low verbal males, high SV/ low verbal females, low SV/ high verbal males, and low SV/ high verbal females. Each participant was interviewed during each year and every time they were required to solve mathematics problems by drawing pictures and then to explain why they did so. In this study, no significant difference was found among groups in ability to solve mathematical problems, but differences in patterns of problem solving were detected: high SV/ low verbal groups tried to translate more information into pictures to solve problems, while low SV/high verbal groups tended to respond to problems by providing more relevant verbalinformation.

A large difference was also found within the female groups in terms of how much help was needed: the low SV/ high verbal females needed the most help to complete a picture to help solving problem, while the high SV/ low verbal females needed the least help. But the difference between the two male groups in this respect was small. Battista (1990) conducted a study among 145 high school geometry students from middle-class communities. This research examined the role that spatial visualisation and verbal-logical thinking played in gender differences in geometric problem solving in high school. The findings unconventional problems are those problems that can be solved by using of logical estimation or insight or usual using of familiar algorithms, which are not presented frequently in textbooks. Zhu 191 suggested that males and females differed in the level of discrepancy between spatial and verbal abilities. The discrepancy between spatial and verbal skills was related to geometric problem solving for both genders. In addition, this study indicated that males with greater ñdiscrepancy of spatial visualisation over verbal-logical abilityò (Battista, 1990, p.57) were more likely to use visualisation strategies than to use drawing strategies in problem solving. However this conclusion only held for males, in another words, the discrepancy between spatial and verbal abilities do not influence femalesô strategy use in geometric problem solving. However, not every researcher shares the opinion that strategy choice and strategy efficiency is determined by the level of ability. Burin et al. (2000) found that there was no such a relationship at least on visualisation tasks. So why do females and males develop different strategies if there is no such a relationship? There are also some other considerations. Gallagher et al. (2000) suggested that males tended to be more flexible than females in applying solution strategies. Kessel and Linn (1996) and Gallagher (1998) reported that females were more likely than males to adhere to classroom-learned procedures to solve problems, so they might be less likely to use shortcuts and estimation techniques for solving unfamiliar and complex problems quickly. Meyer, Turner and Spencer (1997) reported that ñchallenge avoidersò were more likely than ñchallenge seekersò to use surface strategies which required minimal processing of information to solve problems. Carr et al. (1999) found that first-grade boysô strategy use was related to perception of adultsô attitudes toward various strategies and teachers instruction, while this relationship was not applicable to first-grade girlsô strategy use. Quinn and Spencer (2001) suggested that the interference of stereotype threat with femalesô ability influenced femalesô selection of problem-solving strategies. This evidence discussed above indicates that strategy use in mathematical problem solving may be influenced by learnersô psychological characteristics.

Many researchers suggested that mathematical problem-solving strategies responded to training (for example, Hyde et al., 1990). A meta-analysis (in Hembree, 1992) of 487 studies on problem solving found a positive impact on studentsô problem solving performance resulted from instruction especially being trained in heuristical methods. Ben-Chaim et al. (1988) found that both genders benefited significantly from the training program on spatial visualisation (SV) skills. However, the instruction in their study did not eliminate sex differences in SV skills. I assume that the applied instruction in this study may not be effective in the same way for females and males, although there is no evidence to support my opinion from their article. Would gender specific instruction eliminate or minimise gender differences in mathematical skills and to what extent should gender specific instruction be given with respect to different types of mathematical problems? These issues remain to be investigated in the future. In my reviews of published studies, I did not find much research concerned with how characteristics of classrooms and teachers contributed to gender differences in strategy use during mathematical problem solving. However, some studies indicated that these variables were related to gender differences in mathematical achievement (Petersen and Fennema, 1985). Another small piece of evidence was that first-grade girls did not benefit as much as did boys from their perceptions of teachersô beliefs and instruction to develop their strategy use for problem solving from the very beginning of their academic training (Carr et al., 1999). In order to develop effective teaching to facilitate studentsô mathematics learning, these issues also need to be 4 ñChallenge seekersò and ñchallenge avoidersò were defined by Meyer et al. (1997) in their study as two different students groups based on the level of self-perception and behaviours. 192 Gender differences in mathematical problem solving patterns: A review of literature addressed in future research studies.

Many factors were suggested by researchers to make a contribution to gender difference in mathematical problem solving. A main line of research has focused on the gender differences in problem solving abilities. In this area, spatial abilities were of major concern. Another line of research paid attentions to speed of problem solving, in which a Math-Retrieval hypothesis is still in hot argument among some scholars (see, Gallagher & Kaufman, 2005). This section reviews some related studies that have examined gender difference in these factors with relation to mathematical problem solving. Since 1974 when three cognitive abilities (verbal, quantitative and visual-spatial abilities) were identified by Maccoby and Jacklin (1974) as the loci of sex differences, numerous studies have been intrigued to confirm and extend their conclusions as a result. One line of research focused on the relationship between these cognitive abilities and gender differences in mathematical problemsolving. However, evidence from these studies is inconsistent and sometimes conflicting.

Summary of Literature Review

Several researches on problem solving have demonstrated that cognition has a role to play in problem solving. Sternberg (2003), Schacter (2000) and Kimura, (1996) have shown that problem solving is a cognitive task that required the solve to go through some cognitive processes of thinking deciding, reasoning, and understanding the language of the problem. This informed studies on the contribution of cognitive style, cognitive abilities and expertise to the solving of complex problems. Martinsen (1998) asserted that cognitive style is an important variable in determining how people deal with novel by as it describes preferences for strategies or preferred ways of using oneĝs abilities and that people differ in how they use abilities in a given situation, (Martonsen, 1995, PP, 436- 437). As criterion for problem solving performance, insight problems were used in his research because they are generally considered ill- defined and high in novelty. Some theories are in support of the study such as information processing theory, suggested that by providing field dependent learners ample time and practice activities, the encoding differences between field dependents and field independents could be accommodated. Goodenough (1976) proposed a hypothesis that field independent learners and field dependent learners differ in terms of attentional processes. He states that in solving concept-attainment problems, field dependent learners are mainly dominated by the most noticeable or salient features of a stimulus. They tend to ignore many other features of a complex stimulus and are easily distracted by irrelevant cues. These differences become more amplified when the amount of information is increased and irrelevant cues are presented. Meta theory showed that Goodenough (1976) proposed a hypothesis that field independent learners and field dependent learners differ in terms of attentional processes. He states that in solving concept-attainment problems, field dependent learners are mainly dominated by the most noticeable or salient features of a stimulus. They tend to ignore many other features of a complex stimulus and are easily distracted by irrelevant cues. These differences become more amplified when the amount of information is increased and irrelevant cues are presented. These representations in turn affect problem-solving performance. It may prove fruitful to combine elements of the progress monitoring theory and the representational change theory. More specifically, progressive monitoring theory predicts when problem solvers will seek insight and representational change theory predicts how insight is achieved. The key assumptions of Ohlssonôs representational change theory are: the way in which a problem is currently represented or structured in the problem solverôs mind serves as a memory probe to retrieve related knowledge from long-term memory, the retrieval process is based on spreading activation among concepts of knowledge in long-term memory, a block/impasse occurs when problem representation is modified, the block is broken when the problem representation is changed. The Gestaltists claimed that insight involve special processes, and so is very different from normal problem solving. Metcalfe and Weibe (1987) reported relevant findings. They recorded participants feelings of ñwarmthò (closeness to solution) while engaged in solving insight and non-insight problems. There was a progressive increase in warmth during non-insight problems. Recently a dynamic theory of context has been proposed (Kokinov, 1995) where context is considered as the set of all entities which influence human cognitive behavior on a particular occasion. All these context elements are elements of human working memory. According to Martinsen (1995) "the theory of assimilative and explorative (A-E) cognitive styles (Kaufmann, 1979, 1983) has a particular potential to explain the relation among experience, problem solving and creativity" (p. 292), Kaufinannôs A-E theory is "based on cognitive schema theory with special reference to Piagetôs core concepts of assimilation and accommodation" (Martinsen & Kaufmann, 1999, p. 277). The postulate of the A-B cognitive-style theory is that differences exist between individuals and their tendency to rely on past experience when required to think in a new and different way and "these individual differences are linked to dispositions towards using general, heuristic strategies, which are posited to have implications for performance on different types of tasks". Therefore some of the empirical review are equally in support of the study. Ericson and

Kintsch (2004) tested whether context will have a significant effects on problem solving, (200) undergraduates students (128 males and 72 females with a mean age of 96.4 years) participated in the experiment. They were to be assigned to different context condition that is (far and near) environment. The participants were drawn from the population f law students of Harvard University. The study examined the difference between far and near context in problem solving using mathematics set. Result showed that those students who solved mathematics sect in near context environment performed better than those students far environment in solving mathematical problem. Cognitive psychologists have acknowledged a difference between field-dependent and field independent cognitive style. Cantario and Mason (2000) studied that in almost all situations, students performances are better on field independent test that on problem solving. Most experimental studies indicate that field-independent is easier than field-dependent. (e.g. Mayer & Wiltrock, 1996). The most widely used method of assessing knowledge of any psychological construct asks participants to choose from a list of correct and distracter items. The task is one of problem solving. Another method of assessing participantsô knowledge has been the use of open-ended question or other types of problem solving. Although these methods have been applied in different settings; results suggest that the two methods yield very different results. Barbieri and Light (1992) studied interaction, gender, and performance on a computer-based problem solving task. This paper reports a study in which 66 eleven and twelve year old children worked in boy-boy, girl-boy or girl-girl pairs on a novel problem-solving task on a computer. All were post-tested a week later individually, using a slight variant of the same task. Interaction in the pairs was analyzed from videotape in terms of verbally explicit planning, negotiation, etc. These interaction variables were examined in relation to the levels of success attained both as a pair and at individual post-test. Significant though fairly modest levels of correlation were obtained. Analysis also focussed on the issue of gender. The different gender pairings did produce different patterns of interaction (with, for example, marked dominance patterns in the mixed pairs), but the substantial advantage of boys over girls in terms of final performance turned out to be largely independent both of pair type and of the verbal interactional measures used. . Heather, Casper and Camp (1995) studied gender differences in general knowledge, and the degree to which these are a function of difference in problem solving ability. The sample comprised 1200 undergraduates (625 male and 575 female) who ranged in age from 18 ï 45 years. (female. Mean age = 25.5.years, male mean age = 336.5 years) participants were measured on a short from of the General Knowledge Test (GRT) Result showed that males score more highly than females on problem solving of General Science (- 45) and Government, where as females scores more highly on medicine (.25) and fashion (.09). Although females did better than was predicted, the magnitude of the effect of gender on problem solving of general knowledge provides strong evidence that male have a larger advantage on problem solving of general knowledge.

Hypotheses

Following the review of literature, the following hypothesis will be tested in this study.

(1) There will be a statistically significant effect of context on problem solving.

(2) There will be a statistically significant effect of cognitive style on problem solving.

(3) There will be a statistically significant influence of gender on problem solving.

CHAPTER THREE

METHOD

Participants

Two hundred and forty (240) (120 males and 120 females) participated in the study. The participants were drawn from the population of SS II and SS III students of University of Nigeria secondary school, Enugu Campus (UNEC) Enugu State. Stratified random sampling technique was used for sample selection. Male and female students were divided into different strata and from each stratum 120 participants were randomly selected. Participantsô age ranged from 14 ï 19 years with a mean age of 16.5 years

Materials

Two sets of materials were used for this study. The first material was the Oltman, Raskin, Herman and Witkin (1971) Group Embedded Figures Test (GEFT). This test was used to classify participants into field dependent and field independent cognitive styles. The test is a perceptual test that requires a person to locate 8 simple figures when they are embedded within a large complex figure. The test contains three sections. The first section, having seven items, is used for practice, while the last two sections, with nine items each, were scored. Each figure correctly located within the group embedded figures was scored 1. Scores on the GEFT reflects abilities in perceptual disembeding. The higher the score the higher the cognitive style is field dependent. A median point (9) was used as a cut-off point. Thus, participants who score 9 and above were classified as field dependent. According to Witkin, Oltman, Raskin, and Karp (1971), the GEFT has satisfactory reliability of .89 on test-retest over a three year period. The validity was established by correlating the two major sub-sections of the test and an index of .82 was obtained. Omer (2014) using a sample of 157 undergraduate students reported a reliability coefficient of. 82 and found validity with criterion variables in the range of. 63 to .82.

GEFT has been used with a Nigerian sample by Amazue (2006). He tested the reliability of the instrument, using the split- half method and it yielded a reliability index of r= .39, and when corrected with the spearman- Brown formula yielder r = .56.

The second material was the puzzle box that was used to measure problem solving. The puzzle box is made up of twenty six (26) letters (from A-Z) that are randomly mixed in two hundred and eight (208) cells (see appendix II). The problem was for the participants to trace twenty words (see appendix II) from the puzzle box within 10 minutes. The quality of every test is measured on its ability to test what it is designed to test and its power for generalization (Geo-Puzzle, 1999). Thus, content validity was established by giving the test material to three (3) judges in experimental psychology to determine the appropriateness of the stimulus items as a measure participantộs problem solving ability. Based on the assessment of experts, the stimulus items were found to be a valid measure of problem solving ability of secondary students SSI and SSII. Participants were requested to use the letters to select twenty (20) words. Each word selected correctly attracted one (1) point. A pilot test was conducted to assess the internal consistency of the puzzle game problem task. Sixty (60) participants were randomly selected from SSI and SSII students of St. Cyprian Secondary School Abakpa Nike Enugu (age ranged from 15-20 years). Analysis of the raw scores yielded a split-half reliability coefficient of .63.

Procedures

Two hundred and forty (240) copies of group embedded figures Test (GEFT) were administered to selected participants in the two groups. Before administering the test, the participants were told that the test is not for examination but for research purpose. Thereafter, the test materials were administered to the students. The first section of the test comprising seven (7) items, were used for practice with the participants. After the practice session, participants were given 8 figures for them to locate in 18 embedded figures. Specifically, the participants were given the following instructions.

> *"This is a test of your ability to find a simple form when it is hidden within a complex pattern. Try to find the simple form in the complex figure and trace it with pencil directly over the lines of the complex figure. It has to be the* SAME SIZE, *in the* SAME PROPORTIONS *and* FACE THE SAME DIRECTION *within the complex figure as when it appeared alone."*

After this, participants were randomly assigned into two groups; same context (where instruction was given, i.e. the same environment (hall) where participants were taught how to play the puzzle game) and different context (where instruction was not given, i.e. a different environment (hall) from where participants were taught how to play the puzzle game). Participants in the two conditions were then given the following instructions.

> *"You are welcome to this experiment. When you settle down, you will be given a puzzle box to solve. Your task is to trace 20 letter words from the puzzle box. Trace the words either upward, down ward, right ward or leftward mode. You are given 10 minutes to trace the words. The words are: GOD, BEER, SAN, TURN, YOU, MASS, TUTOR, EXTEND, BALLAD, ADVERTISE, EDUCATION, ADAGE, ZEAL, LOAN, NEXT, VISION, SEED, MODERN, ZOOLOGY, and MOMENTUM"*.

After the participants in the two conditions had received their instructions, they were then presented with the puzzle box of 26 alphabets in papers and were allowed 10 minutes to solve the remaining two sections of nine (9) items each.

A research assistant was employed to assist the researcher in conducting the experiment. During the testing period, no participant was allowed to talk to another or look at another participantôs answer. After the 10 minutes elapsed, the researcher together with the research assistant collected the answer sheets with participantsô identification number attached. Finally, the participants were debriefed and rewarded with pencils each.

Design / Statistic

The design of the study was a 2 context (the same vs different context) x2 cognitive style (field-dependent vs field-independent) x 2 gender (male vs female) factorial design. Three way analysis of variance (ANOVA) was used for data analyses.

CHAPTER FOUR

RESULTS

The data generated from this experiment were subjected to a 2 (Context: Same VS different) x 2 (Cognitive: field independent Vs field dependent) x 2 (gender: male vs female) analysis of variance using scores on problem solving as the dependent variable.

Table 1: Table of mean ($\overline{X}$) and standard deviation (SD) for the independent variables and the dependent variable.

Treatment	$\overline{X}$	**SD**	**N**
Context			
Same	15.90	2.21	120
Different	15.57	2.25	120
Cognitive style			
Field Independent	16.38	1.92	144
Field dependent	14.77	2.33	96
Gender			
Male	16.29	2.17	146
Female	14.87	2.06	94

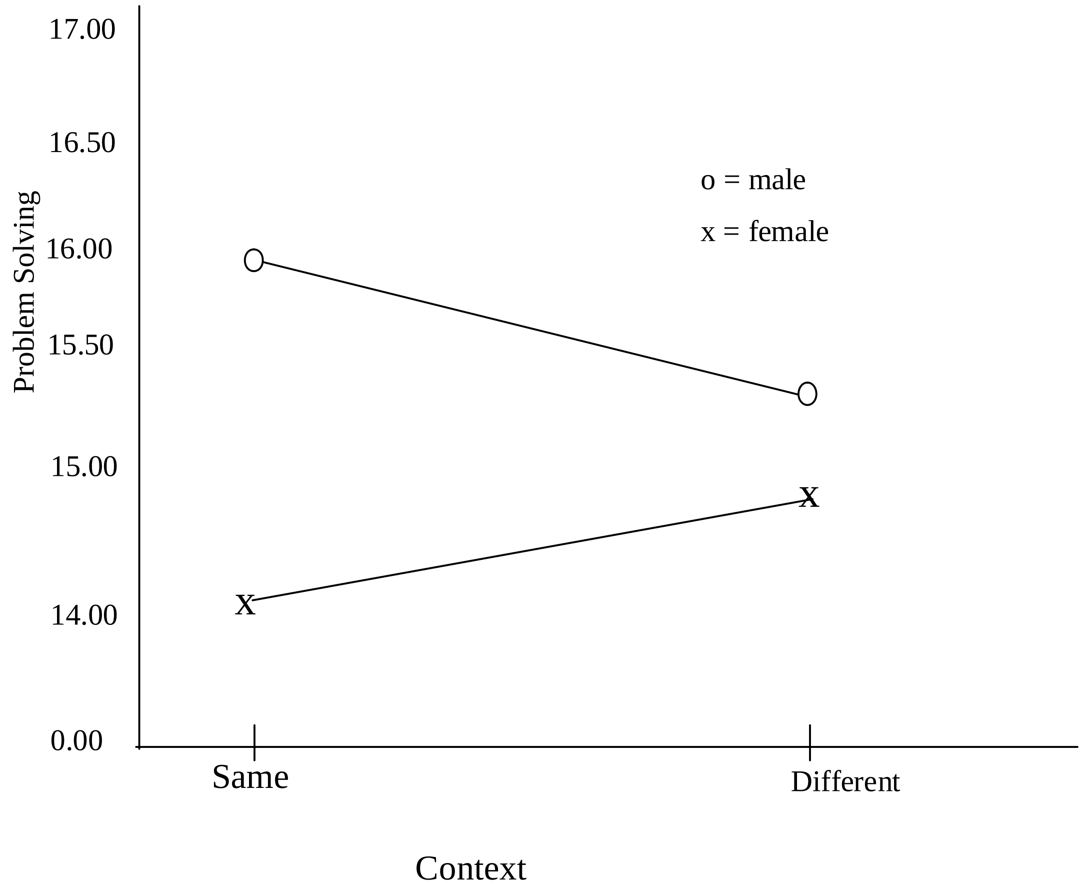
Mean results show that participants who solved puzzle problems in same context had a mean score of 15.90 (SD = 2.21) while those in different context had a mean score of 15.57 (SD = 2.25). Also participants with field independent cognitive style had a mean score of 16.38 (SD = 1.92) which is higher than those with field dependent cognitive style with a mean score of 14.77 (SD = 2.33). Furthermore, male participants had a mean score of 16.29 (SD = 2.17) while female participants had a mean score of 14.87 (SD = 2.06).

Table 2: ANOVA Summary table for the independent and dependent variables

SOV	SS	DF	MS	F	Sig.	Eta
Context (A)	6.42	1	6.42	1.69	.195	.007
Cognitive style (B)	159.21	1	159.21	41.88	.000	.153
Gender (C)	106.47	1	106.47	28.01	.000	.100
(A X B)	13.84	1	13.84	3.64	.058	.015
(A X C)	20.75	1	20.75	5.46	.020	.023
(B X C)	1.60	1	1.60	.42	.518	.002
(A X B X C)	1.27	1	1.27	.33	.565	.001
Error	881.99	232	3.80			
Total	60600.00	240				
Correlated Total	1190.93	239				

ANOVA results as shown in Table 2 revealed a non significant effect of context on problem solving [F (1, 232) = 1.69, ns]. There was however a significant effect of cognitive style on problem solving [F (1, 232) = 41.88, P <.001]. From the mean scores it was found that participants with field independent cognitive style (16.38) performed better in problem solving task than those with field dependent cognitive style (14.77). Result also showed a significant gender main effect [F (1, 232) = 28.01 P < .001] with males (16.29) tending to perform better in puzzle problem solving than females (14.87). There was no significant context X cognitive style interaction effect [F (1, 232) = 3.64, ns]. However, significant context X gender interaction effect was obtained [F(1, 232) = 5.46, P < .05]. There was no significant cognitive style X gender interaction effect [F (1, 232) = .42, ns] and also context X Cognitive style X gender interaction effect [F (1, 232) = .33, ns]. The significant context X gender effect was plotted in a graph as shown in figure 1.

Figure 2: Graph showing the interaction effect of context and gender.



Result showed that higher performance for males are found on same context while that of females was found in different context. However, for both same and different contexts male participants performed better in puzzle problem solving task than female participants.

CHAPTER FIVE

DISCUSSION

This study examined the effect of context, cognitive style and gender on problem solving. The first hypothesis which stated that there will be a statistically significant effect of context on problem solving was rejected in this study. The results showed that there was no association between same context and different context on problem solving. This is a surprising finding because several studies have reported significant effect of context on problem solving. For example, Ericson and Kintsch (2004) found that those who solved problems in near context environment performed better than those in far environment. Also, Smith, Glenberg, and Bjork (1978) reported that problem solving was better when participants were tested in the same room in which they had learned than a different room (see also Godden & Baddley, 1975). The context manipulation might be the reason for the finding in this study. The fact that the experimental group was tested in different environment (class room) may not have produced the desired effect because the participants are familiar with both environments. If the manipulation was such that the different environment was relatively far the result may have been in line with that of Ericson and Kintsch (2004). This is because the distance would create conflicting situational features that may interfere with problem solving process.

The second hypothesis, that there will be a statistically significant effect of cognitive style on problem solving was confirmed. From the mean scores it was found that participants with field independent cognitive style performed better in problem solving task than those of field dependent.

Several studies support the findings in this study. Happel (1994) found that field independent participants were more accurate in problem solving than their field dependent counterparts even without any order of problem factor effect. Squaire and Knowlton

(1993) reported that participants who did better in simultaneous and quadratic equation problem demonstrated significantly higher knowledge of field-independent in problem solving when compared with those field-dependent. Same was found for general mathematical problems (Nielsen, Pickiech & Somonton, 2008), as well as science, engineering, and architecture (Witkin et al., 1977). Field independent learners have also been found to be better at concept attainment (Goodenough, 1976) and were more likely to choose courses related to science and field dependent students were more likely to include courses from the humanities and social sciences (Witkin & Moore, 1974). Although other researchers reported that field dependents and field independents perform equally well on a simple learning task (Hommel, Colzato, Fischer & Christofel, 2011) the general conclusion was that as the learning task becomes more difficult, field independent learners perform better than field dependent learners (Daniels & Moore, 2000)

Among all the cognitive styles, the dimension of field dependence and independence, which reflects oneǿs mode of perceiving, remembering, and thinking, has emerged as one of the most frequently studied cognitive style (Jonassen & Grabowski, 1993). This is because it ñinvolves perceptual and problem-solving ability, structuring a stimulus field, breaking up or disembedding such a field, suppressing irrelevant information, and dealing with high information load, all of which are relevant to the instructional processò (Reardon and Moore (1988, p. 354). The characteristics of being dependent or independent in cognitive style therefore reflect individualǿs preferred modes of relating to, classifying, assimilating, and organizing their environment (Ramirez III & Castaneda, 1974) and which affect their problem solving ability. Field independent individuals are active in processing information with a hypothesis-testing approach. They analyze existing organization and impose structure on a field when it lacks a clear or inherent one (Witkin & Goodenough, 1981). They focus their attention on task-relevant information and ignore distractions better than field dependent individuals (Davis & Cochran, 1990). Field independents who approach a field in an analytical way and extract elements from its complex background have greater disembedding ability in perceptual functioning and better cognitive restructuring than field dependents (Jones, 1993). Indeed, a key difference between field dependents and field independents is the cognitive restructuring ability. Cognitive restructuring involves providing structure for an ambiguous stimulus complex, breaking up an organized field into its basic elements, and the ability to draw upon internal referents (Witkin et al., 1962). Cognitive restructuring skills have been viewed as essential to problem solving (Jonassen & Grabowski, 1993). That is why when ambiguous information is presented under an unstructured context, field independents outperform field dependents (Witkin, 1978).

Field dependent individuals are passive in perceiving information and accept the structure of a field as it exists. They tend to perceive information in a holistic manner without attending to relevant cues (Davis & Cochran, 1990). Field dependent learners may require more explicit instruction and feedback when undertaking problem solving tasks, more detailed descriptions about instructional goals and objectives, and more externally reinforcement than field independent learners (Witkin et al., 1977). Garity (1985) found that field dependent individuals (a) seek verbal and nonverbal feedback, (b) are motivated by social approval, (c) prefer to be emotionally and physically close to others, and (d) are more sensitive to faces and social cues. Thus, ñField dependents are disadvantaged in unstructured situations, whereas Field independents tend to provide their own structure more readily; Field dependents prefer directions and feedback, whereas Field independents are less dependent on feedback; Field dependents rely more on others for information, whereas Field independents are less influenced by peersò (Jones, 1993, p. 199). This differential characteristic compensates the Field independents in a problem solving situations as found in this study.

The third hypothesis which stated that there will be a statistically significant effect of gender on problem solving was also accepted. The result males tended to perform better in puzzle problem solving their females. Researchers have reported similar findings. In a cross cultural study using Ganaian and Norwegian participants, Amponsah and Krekling (1997) reported that males performed better than females in four visual spatial ability tests (water level, surface development, PMA space, and Vandenberg-Kuse). Heather, Casper and Camp (1995) found that males score more highly than females on problem solving of General Science and Government, where as females score more highly on medicine and fashion. Although females did better than was predicted, the magnitude of the effect of gender on problem solving of general knowledge provides strong evidence that male have a larger advantage on problem solving of general knowledge.

Some researchers have however reported counter findings. For example, Cox and Water (1986) examined the use of organization strategies with categorizable word list on 1st, 3rd, and 5th grade children and reported that only females demonstrate significant levels of organization in 1st grade, under the more favourable semantic processing conditions. In the 3rd grade, both males and females show significant levels of organization, but only under semantic orienting task instructions. In the 5th grade, females generalize the use of organization to the less favourable standard processing conditions. Result from experiment 2, showed no use of organization for males or females in 3rd grade with unrelated word lists, and significant levels of organization for females in 5th grade, but only under more favourable processing condition. Gender differences were not only pronounced across the ages tested, but was consistent with the principle of strategy development in general, with males showing a developmental lag in the use of organization strategies across age.

It seems research on gender differences on problem solving needs much to be desired. This is because several factors contribute to the differential effect. Qualitative differences in problem solving have been suggested to be implicated. For example, Blanchard-fields, Friedda, Jahnke, Heather, Casper, Camp, and Cameron (1995) reported that for situations varying in emotional salience male groups used both passive-dependent and avoidant-denial strategies more than female groups. Problem-focused strategies were used least in high emotionally salient situations. This may lead to differential performance in problem solving. Furthermore, Ding and Harskamp (2006) showed that in collaborative learning in physics, female studentsô learning achievement was sensitive to their partner gender while this was not the case for male students. Moreover, the mixed-gender collaboration seemed to disadvantage female students. Gendered communication styles may be one of the reasons behind this. When female students solve the problems with a male partner, they tend to ask questions or paraphrase problem information. Their male partners, on the other hand, are more likely to provide help and offer suggestions. In mixed-gender collaboration, a great degree of uncertainty can be found among female students. However, females in female-female dyads are not so submissive. They put forward their ideas freely and actively develop problem solving strategies. Collaboration in female-female dyads seems to be better balanced than it is in mixed-gender dyads.

Also, some research has suggested that females perform better than males on verbal-ability tests, while males outperform females on tests of visual-spatial ability (Kellogg, 1995). This finding leads us to the question of whether female and male students use different ways to represent knowledge when solving a problem. That is females tend to convey the problem information and describe the solution verbally, while males are more likely to use pictures or charts to illustrate the problem components and the relationship between the variables. The difference in information representation can affect the way it is processed and ultimately problem solving. Wang (2005) examined the relationships between sex-role orientations and the two conceptually related coping behaviours, namely, response styles and social problem-solving and found that masculinity was related to social problem-solving. Gallagher and De Lisi (1994) also found that in solving problems female students use conventional strategies while males use unconventional strategies. These gender differences in problem solving approach and performance has made the conclusion on gender difference in problem solving very sensitive and researchers should interpret findings with caution.

Individual learner differences are believed to be an important concern in the design, development, and implementation of instructional materials and curricula (Skinner, 1954). Each individual has preferred ways of acquiring, structuring, and processing information. Fundamental issues for education and, in particular, for computer-based instruction concern the effects of individual differences on the effectiveness of teaching and learning and on the design and development of learning environments to maximize learnersô strengths and minimize their weaknesses (Graff, 2003).

Limitations of the study and suggestion for further Research

The first limitation of this study was the smallness of the sample size used with only thirty participants (15 male and 15 females) in each of the eight cells. It may not be easy to get significant results in the factors tested. Another limitation is the choice of the two experimental classes. Although the classes were not the same, especially in their sizes, which may not be conducive enough for the students to solve their problems. The study was done using university of Nigeria Enugu Campus Secondary school SSII and SSIII from one school and state and may not necessarily be applicable to other schools and states.

Suggestion for Further Studies

Based on the limitations and outcome of this study, the researcher suggested future research should adopt the following:

1. A good separate conducive environmental study of the variables to determine the actual effects one has over another.
2. Future researchers should also look into other variables and factors and see how it affects problem solving.
3. In other to cross- validate the outcome of this study future researchers by drawing from other federal and states secondary school populations.
4. Future research may attempt to investigate Age and problem solving. This may yield and interesting result.

Summary and Conclusion

The purpose of this study was to investigate whether context, cognitive style and gender will significantly affect problem solving. Participants in the study were 240 students, 120 male and 120 females, whose age ranged from 14-19 years with a mean age of 16.5 years. The two sets of materials used for the study was Group Embedded figures (GEFT).

This test would be used to classify participants into field dependent and field independent cognitive styles while the second one is puzzle box made up of twenty six (26) letters, used in measuring problem solving.

Data generated were analyzed by 2 x 2 x 2 analysis of variance (ANOVA). Result showed a non significant effect of context on problem solving. There was however a significant effect of cognitive style on problem solving. From the mean scores it was found that participants with field independent cognitive style performed better in problem solving task than those with field dependent cognitive style. Result also showed a significant gender main effect with males tending to perform better in puzzle problem solving than females. There was no significant context X cognitive style interaction effect. However, significant context X gender interaction effect was obtained. Higher performance for males was found on same context while that of females was found in different context. However, for both same and different contexts male participants performed better in puzzle problem solving task than female participants. There was no significant cognitive style X gender interaction effect and also context X Cognitive style X gender interaction effect.

The context manipulation was pointed out as one of the determinants of the first result on context. The fact that the experimental group was tested in different environment (class room) may not have produced the desired effect because the participants are familiar with both environments. If the manipulation was such that the different environment was relatively far there may have been a significant context effect. The characteristics inherent in individuals who are of dependent and independent in cognitive style were discussed. These differences which reflect individualœs preferred modes of relating to, classifying, assimilating, and organizing their environment was seen to affect their problem solving ability. Several factors that explain gender differences in problem solving were also discussed. These include qualitative differences (emotion, passiveness and avoidance), being sensitive to partner gender, gendered communication styles and differential performance on verbal and visual-spatial ability tests as well as sex-role orientations.

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APPENDIX 1

PROBLEM SOLVING TEST

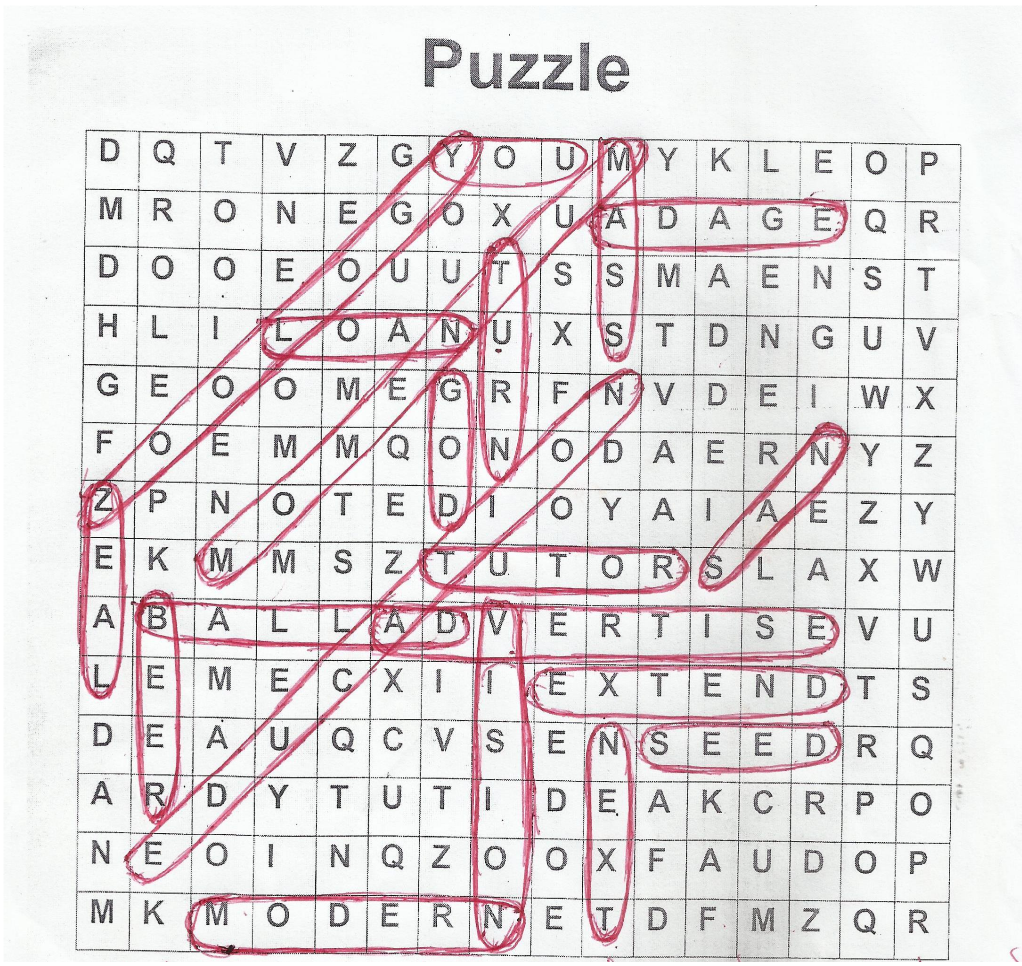
Puzzle

D	Q	T	V	Z	G	Y	O	U	M	Y	K	L	E	O	P
M	R	O	N	E	G	O	X	U	A	D	A	G	E	Q	R
D	O	O	E	O	U	U	T	S	S	M	A	E	N	S	T
H	L	I	L	O	A	N	U	X	S	T	D	N	G	U	V
G	E	O	O	M	E	G	R	F	N	V	D	E	I	W	X
F	O	E	M	M	Q	O	N	O	D	A	E	R	N	Y	Z
Z	P	N	O	T	E	D	I	O	Y	A	I	A	E	Z	Y
E	K	M	M	S	Z	T	U	T	O	R	S	L	A	X	W
A	B	A	L	L	A	D	V	E	R	T	I	S	E	V	U
L	E	M	E	C	X	I	I	E	X	T	E	N	D	T	S
D	E	A	U	Q	C	V	S	E	N	S	E	E	D	R	Q
A	R	D	Y	T	U	T	I	D	E	A	K	C	R	P	O
N	E	O	I	N	Q	Z	O	O	X	F	A	U	D	O	P
M	K	M	O	D	E	R	N	E	T	D	F	M	Z	Q	R

How to play the game: Find 20 words in the chart either in upward, downward, rightward or leftward mode.

GOD	BEER	SAN	TURN
YOU	MASS	TUTOR	EXTEND
BALLAD	ADVERTISE	MOMENTUM	ADAGE
ZEAL	LOAN	NEXT	VISION
SEED	MODERN	EDUCATION	ZOOLOGY

SAMPLE OF SOLVED PROBLEM SOLVING TEST



Puzzle

D	Q	T	V	Z	G	Y	O	U	M	Y	K	L	E	O	P
M	R	O	N	E	G	O	X	U	A	D	A	G	E	Q	R
D	O	O	E	O	U	U	T	S	S	M	A	E	N	S	T
H	L	I	L	O	A	N	U	X	S	T	D	N	G	U	V
G	E	O	O	M	E	G	R	F	N	V	D	E	I	W	X
F	O	E	M	M	Q	O	N	O	D	A	E	R	N	Y	Z
Z	P	N	O	T	E	D	I	O	Y	A	I	A	E	Z	Y
E	K	M	M	S	Z	T	U	T	O	R	S	L	A	X	W
A	B	A	L	L	A	D	V	E	R	T	I	S	E	V	U
L	E	M	E	C	X	I	I	E	X	T	E	N	D	T	S
D	E	A	U	Q	C	V	S	E	N	S	E	E	D	R	Q
A	R	D	Y	T	U	T	I	D	E	A	K	C	R	P	O
N	E	O	I	N	Q	Z	O	O	X	F	A	U	D	O	P
M	K	M	O	D	E	R	N	E	T	D	F	M	Z	Q	R

APPENDIX 2