ATTAINING AUTOMATICITY THROUGH THE TRAINING FUNCTION

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INTRODUCTION

Are you familiar with the statement, "you never forget how to ride a bike?" Have you every wondered why this phrase lingers from generation to generation? After years of not having ridden a bike, you can one day get on one and ride like you were 10 years old again. However, when you were learning to ride a bike it took time, energy and full concentration. Once it was mastered, the act was almost effortless, except for the actual physical function of the activity. There are many processes similar to bike riding. Remember when you were learning to drive a car. How you had to think about each and every step and concentrated very hard. At that time you never thought you would feel comfortable driving. Now driving is almost an automatic process. When you ride a bike or drive a car you can think of other things rather than just the task at hand. It is almost like performing two tasks at once. You can drive to work and determine your work day schedule simultaneously. The process of accomplishing one task while concentrating on another is defined psychologically as automaticity.

"When a person is automatic in the use of a skill, he or she is not aware of its use" (Howell & Lorson-Howell, 1990; 20). Thus, performing the function with little cognitive effort. When a process or function becomes so natural that a person can perform other functions at the same time they have achieved automaticity. However, the process of learning these functions is anything but easy, and the time it will take for the function to reach automaticity is unknown. Perhaps an attempt to define the process of automaticity and determine the point of automaticity would help in the learning process. Defining these procedures can assist in developing automaticity for other functions. Thus, processes can become automatic more efficiently.

PURPOSE OF THE STUDY

The purpose of this study was to analyze available resources related to automaticity, and determine how it has been utilized. The availability of literature on the subject of automaticity helped determine how the author and the paper explored whether automaticity could be integrated into the training field. If this can be accomplished, perhaps this study can determine what methods of learning automaticity can be utilized in the various aspects of training, therefore, introducing automaticity to another level of learning.

STATEMENT OF THE PROBLEM

Automaticity, as a theory or principle of learning in school settings has been researched extensively. Furthermore, visuals related to how automaticity can be achieved initially and eventually accomplished has also received much attention by scholars. However, very little research has been directly related to the field of training. "The examination of the development of automatic processing has taken place, most often, in the context of memory and visual search tasks" (Kramer, Strayer, & Buckley, 1991; 425). However, automaticity has been described "as a memory phenomenon reflecting the consequences of running a large data base through an efficient retrieval process" (Logan, 1988; 583). If this retrieval process were the case, then it would seem that this theory would be equally useful in the field of industrial training. "There is also abundant evidence that automaticity is learned, which is what makes it relevant to skill acquisition and training" (Logan, 1988; pg. 584). Therefore, this study attempted to determine whether prior research was applicable and related to training for automaticity in an industrial setting and the psychomotor domain of learning. Specifically the study examines the following research questions.

RESEARCH QUESTIONS

1. Can the principles used to teach automaticity in education be used to teach automaticity in training?
2. Are there principles of automaticity used in training now, if so where and how?
3. What methods of training best bring learners to the level of automaticity?
4. Can automaticity training be used in the psychomotor domain of learning?

DEFINITION OF TERMS

To assist the reader throughout this paper, some terms that may be new to the reader or unfamiliar in this context are defined. First it is necessary to define the term automaticity. *Automaticity* is the point at which a process becomes automatic, thus opening the door for other functions to occur simultaneously. "*Automatic processes* are fast, effortless, autonomous or obligatory, consistent or stereotypic and unavailable to conscious awareness" (Logan, 1988; pg. 584) As one can see the definition for automaticity and automatic processes are very similar, therefore they will be used interchangeably throughout this paper. Other variations of automatic processes and automaticity according to Webster's Dictionary are as follows:

automatic --without volition or conscious control; acting or operating in a manner essentially independent of external influence or control

automatism --the theory that the body is a machine whose functions are accompanied but not controlled by consciousness; Performance of an act without conscious control, as in the operation of reflexes.

automate--to convert to automation

automation --the automatic operation or control of a process, equipment or system, the condition of being automatically controlled or operated.

automaton--one that behaves in an automatic or mechanical fashion

LIMITATIONS

This study is limited by the current resources available on the topic of automaticity. The majority of the research has been done in fields other than training, and the emphasis on training in yet unknown. One can not be certain that if a theory is applicable to one area of study, it is applicable to another.

DELIMITATIONS

The parameters of this study will focus mainly on where automaticity exists, the theories surrounding automaticity and the methods of attaining automaticity. The review of literature is based on previous information presented on the topic of automaticity and conclusions will be derived from this information.

IMPORTANCE OF THE STUDY

This study is important as automaticity is the key to unlocking available human resources, as well as, increasing human efficiency. According to Gordon Logan "automatic processes use fewer of whatever resources the task used to begin with. Performance becomes more efficient--that is, cheaper--with practice" (Logan, 1988; 586). At a time when resources and efficiency are in great demand, a process that would help increase both would be an enormous advantage.

Automaticity is believed to utilize a person's resources to their fullest potential. "There is a limit on the availability of resources, such as working memory, information-holding capacity, processing time, and so on, that can be expended in an interaction" (Peters, 1983 p. 87, as cited in Gatbonton, &Segalowitz, 1988; 475). If this is the case, it is necessary to delve into the mechanisms of automatic processing. "Automaticity will have increased the amount of those resources required, and this is difficult to reconcile with the modal view that automatic processing is efficient" (Logan, 1988; 586). Efficiency through automaticity is another reason why it is imperative to investigate automatic processing.

Efficiency of resources is one of the many reasons why automaticity is an attractive theory. "Once a skill has been developed to a high level of automaticity, it requires frequent use but very little special practice to maintain at that level. If it has been developed to an automatic level, the process can be used with great economy of effort. That is, it is a very efficient process that involves a minimum of wasted motion or effort" (Bloom, 1988; 74). "Until students attain certain minimum levels of speed and accuracy on individual curriculum tasks, they typically lack the ability to maintain steady performance levels for extended periods of time. On the other hand, when learners approach fluency--accurate, nonhesitant performance they become able to work steadily for significant durations" (Binder, Haughton, & Van Eyk, 1990; 25). This suggests that once a skill has reached the level of automaticity it can be maintained at this level for long durations. Therefore, a worker who is working at automaticity is more efficient than a worker who is not at automaticity.

The data related to fluency and how nonhesitant performance seems to imply that automaticity can be useful in the area of training. The following definition of automaticity explains the relationship of this theory to training. "Man-machine skills exist when humans adapt to the different types of equipment, and when they use them frequently enough they develop a high level of automaticity. A possible danger in automaticity with machines is the chance of serious accidents unless the operator maintains sufficient vigilance" (Bloom, 1988; pg. 75-76). With the implication of danger "certain skills must not only be mastered, but must be brought to a state of automaticity" (Salisbury, 1990; 23) to reduce the possibility of harm on the job. Perhaps the real question is not should a skill be automatic when it is performed on a daily basis but should automaticity exist even when the skill is not often used? For example, if an airplane pilot has to make an emergency landing, but does not perform this function on a daily basis, should this skill be automatic? With this in mind, the study of automaticity becomes much more important than one might realize at first glance. Thus Bryan and Harter state: "There is no freedom except through automatism" (Bryan & Harter, 1899; 369).

PLAN FOR THE REST OF THE STUDY

This study is a Qualitative Descriptive Study designed to thoroughly examine the subject of automaticity. Chapter 2 will consist of an in depth review of the literature previously done on the topic. Chapter 3 will be the methodology section. Chapter 4 will consist of a summary, conclusions and recommendations derived from the literature review, and any contemporary theories that may have surfaced from research for this study.

Chapter 2

REVIEW OF LITERATURE

Speculation regarding automaticity has occupied the interest of educators since 1899. The purpose of this chapter is to investigate some of the literature surrounding automaticity. That discussion focused on the theories of automaticity, and methods of attaining automaticity. Primarily, the chapter discussed where automaticity occurs, the theories surrounding automaticity and the methods for attaining automaticity. Initially, this chapter addressed the criterion of determining whether a process has reached automaticity.

Automaticity is the point at which a process becomes automatic, which opens the door for other functions to occur simultaneously. Automaticity has been called "a product of learning" (Logan, 1990; pg. 2). However, in order to reach automaticity one must distinguish between controlled and automatic processes. There is a fine line between a controlled process and an automatic process, and a determination must be made between the two when training for automaticity.

"Controlled processing is slow, serial, and limited by the capacity of short-term memory" (Logan & Stadler, 1991; 478-479). "Controlled processes are voluntary, require attention, and are relatively slow" (Cohen, Dunbar & McClelland, 1990; 332). "Controlled processing represents a temporary sequence of operations that are under the control of the subjects, require active attention, and are capacity limited" (Kramer, Strayer & Buckley, 1991; 425).

"Automatic processing is fast, parallel, and not limited by the capacity of short-term memory" (Logan & Stadler, 1991; 478). "Automatic processes are fast, do not require attention for their execution and therefore can occur involuntarily" (Cohen, Dunbar & McClelland, 1990; 333). "Automatic processing is fast, often insensitive onto capacity limits, and difficult to modify once initiated" (Kramer, Strayer, Buckley, 1991; 425). Thus, "an automated process is one that can take place while attention is directed elsewhere" (Stanovick, Cunningham & West, 1981; 57-58). Hence, "automatic processes are more likely to escape attempts at selective attention than are those of a controlled process" (Cohen, Dunbar & McClelland, 1990; 333). There is indication that "neither speed of processing nor interference effects, alone, can be used reliably to identify processes as controlled or automatic" (Cohen, Dunbar & McClelland, 1990; 334).

The learning of a skill, can be reflected by a gradual shift from slow, laborious and controlled serial processing to fast, effortless and automatic parallel processing (Fitts & Posner, 1967; Shiffrin & Schneider, 1977). The criterion for determining whether a skill or subskill is automatic, "is that it can complete its processing while attention is directed elsewhere" (LaBerg & Samuels, 1976; 550).

WHERE AUTOMATICITY IS ACHIEVED

With the many advantages of automatic processes, one can determine the need for automaticity in certain environments. "Automaticity is a major factor in skill acquisition" (Logan, 1988; pg. 583). Automaticity can be achieved in many realms of a person's life. How a person brushes his/her teeth, washes dishes, and eats dinner all become automatic functions. This is because other thought processes are usually occurring at the same time. But is this automaticity? If so, how is automaticity determined? To answer these questions, areas in which automaticity is used extensively will be explored for clarity.

Proficiency in different curriculum, involves the mastery of habits which are associated in some hierarchical fashion (Bryan & Harter, 1899). Research in the area of automaticity is done primarily in the educational realm and has received a great deal of attention in the area of reading and language. Recently, other fields are discovering automaticity, which implies that perhaps automaticity can be attributed to training.

<u>Reading</u>

The greatest amount of information regarding automaticity is found in the area of reading, since reading requires the dual task of word recognition and comprehension. Automaticity occurs when two functions are happening simultaneously, therefore reading must reach automaticity, in order to be efficient.

Studies regarding reading have shown that speedy and efficient word-recognition and word understanding is a critical prerequisite for successful reading. Thus, word recognition and word understanding must become automatized before the reader is able to concentrate on higher order skills, such as concepts and theme (Salisbury, 1990). The implication follows that "certain critical subskills must not only be well learned but overlearned, and through practice, be brought to a state of automaticity" (Salisbury, 1990; 24). During repetitions material is reorganized into higher-order units even before lower-order units have achieved a high level of automaticity (LaBerg

& Samuels, 1976).

Beginning readers need to learn decoding skills, which is interpreted as knowledge of print-to-sound correspondences (Samuels, 1988). Decoding is viewed as a "prerequisite for skilled reading, and results from direct instruction and extended practice in comfortable reading materials" (Samuels, 1988; 756). Once decoding has reached automaticity, comprehension skills will follow. "Comprehension is getting meaning from the decoded material" (Samuels, 1988; 757). Automaticity is achieved when two functions occur simultaneously, such as word recognition and comprehension.

"Skill in word recognition has two stages accuracy and automaticity" (Samuels, 1988; 759). Automatic is interpreted as the amount of effort or energy required to achieve word recognition is significantly reduced. When a person is accurate, but not automatic at word recognition, considerable amounts of mental energy or effort is required, but when a person is both accurate and automatic, the recognition task can be done quickly, and easily, with little effort or energy. "Thus, the goal for fluency in reading must be beyond accuracy to automaticity" (Samuels, 1988; 759).

Scott, Stoutimore, Wolking & Harris' have developed the Challenging Reading Model which includes four steps. Assessment begins at each learner's current reading level and proceeds through passages of different grade levels until a challenging passage is determined (Scott, Stoutimore, Wolking & Harris, 1990). Daily timings on the challenging passage are then implemented. After the daily timings, errors are sited for correction. During the error correction stage, the teacher first points to each word read incorrectly (target word), and says the word correctly. The teacher proceeds by having the learner imitate the teacher's model. Next, the teacher says both words on either side of the target word, and asks the learner to repeat the five-word phrase (Scott, Stoutimore, Wolking & Harris, 1990). In the final stage, repeated reading and rate pacing, the teacher prepares an audiotape on which the appropriate passage was read at a rate approximately 30 words per minute faster than the learner's current performance level (Scott, Stoutimore, Wolking & Harris, 1990). When utilizing this procedure, even learners who seem to have difficulty keeping up, have made significant gains in reading rates (Scott, Stoutimore, Wolking & Harris, 1990; 33). "When these procedures where used to teach challenging reading passages, progress rates for both correct and error responses where high" (Scott, Stoutimore, Wolking & Harris, 1990).

The Challenging Reading theory utilizes a wide variety of comprehension-building methods. It begins with the Schema Theory building upon the students' prior knowledge in order to provide them with a framework with which to associate what they need to comprehend from their new reading (Scott, Stoutimore, Wolking & Harris, 1990). Then the students are immersed into stimulating reading (Scott, Stoutimore, Wolking & Harris, 1990).

The transformation of written stimuli into meanings involves a sequence of stages of information processing. The stages (model) of information processing are: 1) construction of visual codes, 2) relation of the visual stage to the larger picture 3) description acquisition of automaticity (LaBerg & Samuels, 1976). These stages of information processing relate to the strategies of automaticity development. According to Jay Samuels, there are three things that can help a student develop fluency or automaticity in a complex activity: (1) instruct the students so that they become accurate, (2) provide time to practice so the skill becomes automatic, and (3) motivate the students so that they will stay on the task long enough to become accurate and automatic. (Samuels, 1988)

The stages of general information processing and the stages of automaticity in reading are comparable, thus automaticity is not confine to educational purposes. These models have shown not only the necessity of reaching automaticity in reading, but also how it can be applied to other areas.

Language

When a child begins to speak for the first time often words are mispronounced and the child continues this until feedback is given and the error is corrected. But the learning of a language is a slow process and takes much practice. Learning a language requires the ability to reach fluency, which is acquired only through automaticity. Data from existing research reveals there are many ways in which fluency (automaticity) in language can be accomplished.

One such theory begins with an open-ended situation and moves toward more closely controlled situations. Students learn utterances in cognitive contexts closely resembling utterances that will be obtained later. Therefore, the phrases can be more easily recalled. Only after students have learned the uses and functions of these utterances should they focus on them more specifically. This consolidates the control of their production, and possibly examines the formal properties. (Bamford, 1989) The most important thing in this model is the fluency of language, and the understanding and automaticity will soon follow.

Savignon (1983) introduced the Communicative Competence Approach, which represents a major step forward in language teaching by emphasizing the attainment of communicative ability rather than the learning of abstract rules (Gatbonton & Segalowitz, 1988). This is a highly innovative approach where the overall goal is to identify a set of common, utterances that would be useful if they were highly routinized in speech (Gatbonton & Segalowitz, 1988). Utterances which are spoken every day determine what skills need to be automatized for automaticity to occur.

Fluency should begin when a student is accurate, and should be a natural extension of the acquisition of accuracy (Howell & Howell, 1990). The best way to ensure that fluency instruction is effective is to make sure that it is embedded adequately within the total lesson. Posenshine & Stevens (1986) suggest that lessons should include embedded components such as preview, explanation, guided practice, and independent practice (Howell & Howell, 1990).

Mathematics

Proficiency in mathematics requires the ability to automatically apply the various rules of math to any problem. The rules for problem solving would be best not just learned, not just mastered, but automatized (Gagne, 1983).

Gagne's Cognitive Processing model suggests the major phases in performing a mathematical task. The first phase is based on the learners schemata and transfers information from a problem statement to mathematics. Next, the automatic rule-using phase puts the performance in Mathematical operations. Then by combining rule-using and schemata the solution is validated (Gagne, 1983). If there is any proficiency in using mathematics, this phase consists in the automatic application of mathematical rules (Gagne, 1983).

"Unlearning is a matter of extinction. This means that teachers would best ignore the incorrect performances and set about, as directly as possible, teaching the rules for correct ones" (Gagne, 1983; 15). To reach a level of automaticity in mathematics, the procedures must be learned correctly, and then mastered (Gagne, 1983). Automaticity in general follows the same rule. This is also true for any occupation in which automaticity is required.

Occupations

"In mastering an occupation, doubtless the whole man is involved, body and mind, sensation and movement, thought, interest, imagination, will, innumerable known and unknown aspects of our psycho-physical life" (Bryan & Harter, 1899; 345).

Through their research on telegraph operators, Bryan and Harter discovered that lower-order habits often reach a plateau, in which the learning curve is leveling out. At this time the lower-order habits are approaching maximum development, but are not yet sufficiently automatic to leave the attention free to attack the higher-order habits. The length of the plateau is a measure of the difficulty of making the lower-order habits sufficiently automatic (Bryan & Harter, 1899;). "The gain in speed made possible by adding mastery of higher language habits to mastery of the lower, does not lead to less, but to greater accuracy in detail" (Bryan & Harter, 1899; 360).

The work of Bryan and Harter, shows that automaticity has been a researched subject for nearly a century. Yet, it is still very applicable to how automaticity can be utilized in a variety of settings such a military training.

Military

Automaticity has become critical in military training, and several programs have been developed to attain automaticity for different military functions. Because military personnel performs diverse duties that often have their attention split in two or more directions. Automaticity could meet the challenge of increasing attentional capacity. "The military training exercises were devised with two criteria in mind. First, performance on each exercise depends on the information processing involved in the corresponding component. Second, the training tasks are brief enough that students can go through the many hundreds of trials required for proficiency" (Halff, Hollan & Hutchins, 1986; 1137).

The Military utilizes a training method called Computer Based Memorization System (CBMS) which helps students memorize large amounts of factual information. It has three components: 1) a semantic network containing the material to be learned, 2) a knowledge-base manager which can query, inspect, and make inferences from the semantic network so that information can be presented in a number of different forms, and 3) an instruction generator presenting the information to students, tests their knowledge, and oversees the instructional interchange (Halff, Hollan & Hutchins, 1986). There are a number of different formats in which the CBMS is utilized.

SCHOLAR, is an automated tutor that can both answer students' questions and generate questions for students to answer (Halff, Hollan & Hutchins, 1986). STEAMER simulates a steam plant using graphics that are useful for reasoning and problem solving. This system is manipulated by acting upon graphical depictions (icons) of the components present in an actual steam plant (by touching a valve icon, for example, a student can "open" or "close" the valve) and can see the effects of these manipulations by reading gauges and other indicators of the plant's state. These displays permit student to manipulate and observe representations that are like those used by experts and understand as well as reason about the operation of a steam plant (Halff, Hollan & Hutchins, 1986). A third system is called MOBOARD, it provides students with a mapping between the more familiar framework of absolute motions and the unfamiliar concepts of relative motion. "The system makes explicit the more important aspects of the procedures being taught, namely, their goal structure and rationale" (Halff, Hollan & Hutchins, 1986; 1136).

The utilization of automaticity in military functions gives leeway to transferring that information to areas other than education. There are a number of theories regarding the phenomenon. These theories involve a wide range of ideas which aid one in determining how to achieve automaticity.

THEORIES OF AUTOMATICITY

The theories surrounding automaticity are separated into two separate categories, information processing and attention related functions. Both show that there is "evidence that automatic functions can simultaneously serve higher functions" Bloom, 1988; 74). But do theories surrounding automaticity, information processing and attention serve the same purpose?

Attention

"Automaticity is typically viewed as a special topic in the study of attention. It is interesting in this context because automaticity seems to be a way around the limitations of attention" (Logan, 1990; 1). Automaticity as a special topic of attention means that the attention span for automatic processes are different than for those of controlled processes.

According to Brahrick and Shelly, (1988) "some researchers believe that the clearest index of automaticity is that other conscious cognitive processes may take place simultaneously with the automatic processes."

"Some processes, especially in sports and cognitive fields, are done so rapidly under automatic control that the same individual could not even come close to this rate under conscious control" (Bloom, 1988; pg. 74). This refers to muscle memory which is "the mastery of any skill--whether a routine daily task or a highly refined talent--depends on the ability to perform it unconsciously with speed and accuracy while consciously carrying on other brain functions" (Bloom, 1988; 70). This indicates that the act has become somewhat unconscious, that the person is not even totally aware that they are doing the act. Which, gives leeway to other processes to occur simultaneously (Bloom, 1988). "It is generally agreed that highly skillful acts are accomplished with little conscious thought, except for the thought needed to begin the act" (Jensen and Fisher, 1979, 214).

Attention to the act is given at the beginning, and once the process becomes automatic, attention is reduced from that point forward. Unconscious cognitive control can lead to diverting attention to other functions, thus opening the door to greater resources.

Many consider "automaticity as a way to overcome resource limitations" (Logan, 1988; pg. 583). This perception indicates that automatic processes provide an answer for resource barriers. Logan's 1988 Multiple-Resource theory "arose to challenge the single-capacity view of divided attention and dual-task performance arguing that more than one capacity or resource limited performance" (Logan, 1988; 585).

One may agree that automatic processes already exist in many functions of daily life. For many people walking, driving, reading and talking are automatic processes. But, what is the advantage of processes that may not occur daily becoming automatized? Automatizing certain aspects of performance frees up attentional resources. Fundamental to skilled performance in a number of areas is automating, because it allows performers to allocate their limited capacities to where they are most needed. This involves being able to carry out certain activities with little or no investment of psychological resources (Gatbontion & Segolowitz, 1988).

However, a certain amount of attention must have been focused on automatic processes in order for it to reach the level of automaticity. The most common view is that automatic processing is processing without attention. Therefore, the development of automaticity represents the gradual withdrawal of attention (Logan, 1988). Consequently, automaticity can only occur when the amount of attention given to a certain function begins to diminish.

"Automatic processes may include an attention-calling component and even then the components of the process might not reach consciousness, only the results" (Anderson, 1980; 124). This view indicates that a lack of attention is part of what makes automaticity a function that produces results. With the assertion that minimal attention is necessary to perform an automatic function, comes the concept that utilization of automatic processes is preferred over controlled processes.

"The relationship between automaticity and attentional control differs on the terms of specific information-processing mechanisms" (Cohen, Dunbar & McClelland, 1990; 333).

Information processing

The first step of information processing is determining the type of knowledge. Automaticity is often characterized as procedural knowledge which is the knowledge of the process, as opposed to declarative knowledge -- knowledge of fact, "knowing that" something is the case (Logan, 1988). Therefore, automatic functions have gone through certain processes to become automatic. When information is processed into cognition, it is then arranged in their schema.

When a process becomes automatic it becomes part of that person's schema, which means that the effort put into accomplishing the act no longer is as great as when the person was learning the skill. When a new skill is learned, the learner must be able to place the new skill in their cognition. This is done by calling on knowledge that is organized into a variety of schemata (Gagne, 1983).

Gagne (1983) developed and Information Processing theory for developing automaticity, it consists of 3 steps: 1) very basic isolated details that are learned to a high level, 2) emphasizes larger units composed of the isolated details already learned, and 3) emphasizes series of units and processes built out of the previous units, isolate practice of skills and subskills (Bloom, 1988).

The modal, or (most common) view of automaticity focuses on the resource demands. "The revolutionary view is that automaticity is a memory phenomenon" (Logan, 1988; 586).

The memory phenomenon position would assert that "performance is considered automatic when it depends on single-step, direct-access retrieval of solutions from memory rather than on some sort of algorithmic computation

(Logan, 1988; 586). In the memory view, questions arise regarding what must be learned to perform the task, and ways to improve learning (Logan, 1988). Logan assumes that encoding into memory, and retrieval from memory are obligatory consequences of attention (Logan, 1988). The implications of automaticity-as-memory is that people learn according to environment, and remember behaviors appropriate to different states of the environment.

The memory-instance theory states that "resource reduction could be seen as a consequence of atomization rather than a cause" (Logan, 1988; 589). Therefore, in explicit memory tasks, such as recognition and recall, the subject is expressly told to retrieve something from memory, and in implicit memory tasks, the subject is given a task to perform where some of the materials have already been presented. "Automaticity seems more likely to be a phenomenon of implicit memory rather than of explicit memory" (Logan, 1988; 595).

"The instance theory assumes that the memory representation involves associations between an item and the processing episode in which it participated, but it does not specify the nature of the association" (Logan, 1990; 7). In Logan's (1988) theory, for example, performance depends on a race between memory retrieval and a general algorithm or formula for performing the task. At low levels of practice, memory retrieval is slow and unreliable, so performance is dominated by the algorithm. At high levels memory retrieval is fast and accurate and dominates performance (Logan, 1988).

"The moral for the practitioner here is to look more broadly for automatic processes. They need not be restricted to procedural knowledge or perceptual-motor skill, but may permeate the most intellectual activities in the application environment" (Logan, 1988; 596).

With the properties of automaticity being continuous, their emergence depends largely on the strength of a process relative to the strength of the competing processes (Cohen, Dunbar & McClelland, 1990).

The strength of processing model provides a mechanism for measuring three attributes of automaticity. "First, it shows how strength varies continuously as a function of practice; second, it shows how the relative strength of two competing processes determine the pattern of interference; and third, it shows how the strength of a process determines the extent to which it is governed by attention" (Cohen, Dunbar & McClelland, 1990; 334). "This model considers automaticity in terms of a continuum based on strength of processing or indirect processing" (Cohen, Dunbar & McClelland, 1990; 357).

"There is an assumption regarding automaticity that it is an all-or-none phenomenon" (Kaheman & Henik, 1981; MacLeod & Dunbar, 1988). "An alternative conception is that automaticity is a matter of degree" (Cohen, Dunbar & McClelland, 1990; 332). "This interpretation agrees with the general idea that flexible, general-purpose resources are required to perform novel tasks, and only with practice do automatic mechanisms come into play" (Cohen, Dunbar & McClelland, 1990; 347).

The Stroop effect demonstrates the effect of strength of processing, further it illustrates a fundamental aspect of attention, implying that people are able to ignore some features of environment but not others. Finally, the Stroop effect shows the relevant difference between naming colors and reading words thus determining speed of processing (Cohen, Dunbar & McClelland, 1990). Stroop like effects consider the role of attention in processing and stroop-like interference effects can emerge simply from difference in strength of processing (Cohen, Dunbar & McClelland, 1990). "If the outputs of any two processes conflict, one of the two processes will be slowed" (Cohen, Dunbar & McClelland, 1990; 333).

METHODS OF ACHIEVING AUTOMATICITY

This section of the chapter will discuss the many methods used to achieve automaticity. "Students can learn through several presentation modes" (Vockell, 1990; 12). Hence, a variety of methods enhances the development of automaticity. This establishes the importance of discovering many methods of achieving automaticity.

Practice

Practice is the most well-known method of attaining automaticity. "The attributes of automaticity develop gradually with practice" (Cohen, Dunbar & McClelland, 1990; 333). "Processes become automatic as a result of a great deal of practice" (Gatbonton & Segalowitz, 1988; pg. 474).

"The properties (of automaticity) develop because they are characteristic of processes that require little or no capacity, and capacity demands diminish with practice" (Logan, 1988; 585). "Processed-based learning is a process improvement mechanism in which the task is performed in essentially the same way throughout practice, only more efficiently." "Practice improves the efficiency of the comparison process somehow" (Logan & Stadler, 1991; 479).

Practice and automaticity have been studied extensively because of this direct correlation. Models of practice have also been developed, one of which is called the frequency of occurrence model. The frequency of occurrence model has two criteria; 1) people are sensitive to automatically encoded information without intending to be, and 2) disruptions due to arousal, stress, or additional processing demands will have no impact on the processing of such automatically encoded information (Fisk, 1986).

The result of experiments of the frequency of occurrence model are not consistent with Hasher and Zacks who claim that, when a process is automatic frequency processing is immune to intentional and interference effect (Sanders, Gonzalez, Murphy, Liddle & Vitina, 1987). There is an ongoing argument of whether frequency of occurrence is automatic or in reality effortful. The theoretical view of Sanders, Gonzalez, Murphy, Liddle and Vitina (1987), also directly suggests the important components in the empirical determination of automaticity. These empirical components include (a) better-than-chance performance, when (b) subjects are also engaged in a capacity-demanding cover task, so that (c) they are unaware that the process in question is being executed". Along with the frequency model, repetition/priming is also a factor of practice.

Repetition priming is the difference between the increased speed of the second and the first presentation. Repetition and priming are viewed as the first few steps to automaticity. Repetition priming is clearly item specific, and reflects implicit memory (Logan, 1990).

Practice, or variation of practice models, such as: frequency of occurrence and repetition/priming seem to be methods which most agree are necessary in attaining automaticity. However, other functions must also occur if automaticity is to be achieved.

<u>Spaced practice</u>

"There is much evidence in the literature to suggest that short, spaced periods of practice give better results than long concentrated practice periods. Research results indicate that spaced practice was more effective than an equal amount of massed practice" (Salisbury, 1990; 25).

Literature on cognitive psychology contains references to automaticity and its relationship to attention span. Students must attain minimum levels of speed and accuracy on individual curriculum tasks to maintain steady performance levels for extended periods of time. "When learners approach fluency--accurate, nonhesitant performance--they become able to work steadily for significant durations" (Binder, Haughton & Van Eyk, 1990; 25). Long durations of practices may actually depress learning rates. Students who have not yet attained minimal levels of performance cannot be expected to continue working for longer than a brief interval without slowing down considerably or even stopping work (Binder, Haughton & Van Eyk, 1990; 25).

"The learner should be able to resume a drill, picking up with the same items that he or she was working on during the previous session. In some cases, this can be done by dividing the content into difficulty levels and allowing the learner to specify the appropriate difficulty level at the beginning of each session" (Salisbury, 1990; 25). "Most of the properties of automaticity emerge through practice in consistent environments" (Logan, 1988; 584).

<u>Consistency</u>

Consistency can lead to the development of automatic-attention response (Madden, 1980). With extensive practice, consistently mapped targets can show significant development in automatic processing (Madden, 1980).

"Automatic processing which develops as a result of practice with consistent stimulus-response relations, represents a sequence of operations that become active in response to a particular physical or semantic stimulus (Kramer, Strayer, Buckley, 1991; 425). Does consistency relate to the entire task or merely to a critical subset of the task components for automatic processing to develop? "If automaticity can develop for partially consistent tasks, it would be important to determine which components are the critical ones" (Kramer, Strayer, Buckley, 1991; 426). Perhaps performance is improved by performing critical task components rather than the entire task. "In an applied context, the finding that the entire task does not have to be consistently mapped to achieve automatic processing suggests that it may be possible to improve performance by practicing critical task components rather than entire tasks" (Kramer, Strayer, Buckley, 1991; 435).

To reach a high level of proficiency in an information-processing task, it must involve a consistent mapping of stimulus to response and a large number of trials should be given in all stimulus conditions (Halff, Hollan & Hutchins, 1986).

Association

"Automaticity clearly depends on associations" (Logan, 1990; 7). It is helpful if learners associate what is being learned to something with a deeper meaning. This holds the interest of the learners.

The instance theory suggests that stimulus-to-interpretation associations underlie the effects (Logan, 1990). Utilizing the Power-Functions Speed-Up "the instance theory predicts that reaction time will decrease as a power function of the number of repetitions which is characteristic of automaticity" (Logan, 1990; 20-21). The instance theory predicts an associative basis for repetition priming and automaticity.

Training will be more effective if it involves a deeper level of processing, thus, trainees can become involved in the training task in a meaningful way. "The more commitment and interest they show in the training program, the faster they may learn and the better they may retain what they learn in applying their knowledge once training is over" (Logan, 1988; 594).

Context

"Context Effects is when similar context produce better memory performance than dissimilar ones. Context effects are more effective at lower levels of practice or mixed level of practice" (Logan, 1988; 590). "Contextual consistencies may come to be associated with task-relevant consistencies, locking the ability to perform the task into a specific context" (Logan, 1988; 591).

Practitioners can take measures to control the context; "however, they can control the context at training and should design it to take into account the breadth and nature of the context at application." "Another possibility for the practitioner is to discourage or prevent attention to context during training so that context does not become associated with task-relevant information in the memory trace" (Logan, 1988; 591).

There are practical implications that can be learned from Gordon Logan (1988) for the design of training programs. The trainer should anticipate a narrow transfer of information between training and the situations encountered in the field. The emphasis should be on the fidelity of training programs and simulators so that situations encountered in training are as similar as possible to situations encountered in the field when training is applied (Logan, 1988).

Dual-task conditions

"Two tasks performed together present concurrent streams of events, and it is possible that events from one stream become associated with the other" (Logan, 1988; 592). Thus the practitioner should pay attention to tasks that will be performed concurrently with the task being trained. Therefore, trainers "should try to incorporate concurrent tasks similar to those anticipated in application (into training) so that the trainees will have experience with the appropriate context" (Logan, 1988; 592).

However, when working with two tasks or a training situation and then an on the job situation training programs should encourage trainees to try and consider the two tasks separately. Ignoring the context provided by either task so as not to incorporate it into memory traces relevant to the primary task (Logan, 1988).

Computer Aided Instruction

The computer can aid in mastery learning, overlearning and automaticity. Vockell presents an "Instruction principle: With many skills and concepts, it is important to continue studying them and applying them well beyond the point of initial mastery" (Vockell, 1990; 11). He further states that, "learners who fail to master basic skills often continue to fall further behind their peers as these basic skills must be applied to new topics. Computer aided instruction (CAI) can help students practice skills well beyond the point of initial mastery until they become overlearned or automatic" (Vockell, 1990; 11).

"Some students experience severe difficulties when forced to work within one learning mode" (Vockell, 1990; 12). If a different learning style were employed a student could learn much better. CAI has the potential to adapt to different learning styles by using a variety of techniques. Thus, it may be effective to present students with a choice of programs, all designed to teach the same objectives, allowing students to choose the program that suits them best (Vockell, 1990).

Precision Teaching

"Precision teaching is not so much a method of instruction as it is a precise and systematic method of evaluating instructional tactics and curricula" (West, Young & Spooner, 1990; 5).

To be more effective, teachers must clearly specify what they want to teach, provide opportunities for their students to learn, frequently measure the performance of critical skills, regularly analyze the performance data, and adjust instruction according to their analysis (West, Young & Spooner, 1990).

Precision teaching can be a method for achieving automaticity because "in the final analysis, the goal is to help students perform their best, for however long they are able, and then to provide support and practice that will enable them to maintain that performance for as long as they need to do so. Precision teaching is a valuable tool for helping teachers achieve that goal" (Binder, Haughton & Van Eyk, 1990; 27).

Review materials

"The research implies that students should have attained automaticity on component subskills before going on to more sophisticated superordinate skills" (Salisbury, 1990; 24).

"Since the strength of an association is weakened by the learning of new associations, review of old items should be provided as new ones are introduced. Once a subset of items has been learned, new items should be progressively introduced while reviewing systematically information already learned" (Salisbury, 1990; 25). This could be done by setting up a series of review stages allowing mastered items to be reviewed at different stages. An alternative is to provide increasing-ratio review where the ratio of new items to review items changes as the student progresses throughout the drill. As the student masters items, these become review items and are reintroduced systematically into the drill. Toward the end of the drill most of the items the student will be working with will be review items. Drills which are structured in this way might be used very effectively for the purpose of skill maintenance in addition to initial learning (Salisbury, 1990).

"Spaced review has been shown to be a significant means of enhancing retention of learned material." "The further apart the two presentations of a word in the sequence, the higher was the probability for recalling that word, indicating that retention improves with increased spacing between exposure to the material" (Salisbury, 1990; 26). The research on spaced review suggests that computer drills should provide a mechanism to gradually increase spacing between presentations of the material. (Salisbury, 1990)

SUMMARY

The criterion for determining whether a process has reached automaticity is that it can complete its processing while attention is directed elsewhere. Thus, more than one and perhaps many functions can occur simultaneously.

There are many areas in which automaticity is utilized. The educational arena has used automaticity in many situations, applying it to subjects such as reading, language, and mathematics. Automaticity has been sited as being "a major factor in skill acquisition" (Logan, 1988; 583). Therefore new perspectives on automaticity may shed light on practical issues in training (Logan, 1988). The military is one occupation which has frequently utilized automaticity.

Theories of automaticity help determine the characteristics of an automatic process. Most of the theories surrounding automaticity focus on either information processing or attentional functions. Skills or content committed to automaticity needs little attention, thus creating an unconscious cognitive ability, and a way to overcome resource limitation. Automaticity has an information processing method that increases memory capacity and determines the strength of processing. Throughout the theories of automaticity, the characteristics of automaticity is determined, and methods of attaining automaticity can be explored.

The methods of attaining automaticity are relatively straight forward. An integration of a variety of methods that change the automaticity instruction strategy from simple to complex. Practice, including frequency of occurrence and repetition/priming, is the most well known method of achieving automaticity. However, mass practice is not effective, practice should be spaced as well as consistent. Review materials are are imperative throughout the instruction. A variety of media methods make the instruction more productive. Both Computer Aided Instruction and Precision Teaching have been tested and are known to be effective in attaining automaticity.

The abundant evidence that automaticity is learned, is an indication of its relevance to skill acquisition and training (Logan, 1988). Suggesting that automaticity can not only be attained through the training function, but also utilized in any domain of learning with special implications regarding the psychomotor domain.

Chapter 3

METHODOLOGY

This Chapter describes the overall methodology the author used for responding to the stated research problem and questions. The study involved a comprehensive review of the existing literature and research available on the concept or theory of automaticity. The research and data which was read, and used to write Chapter two provided a concrete foundation to the concept or theory of the research problems and questions found in Chapter one. Thus, these findings are reported to reach conclusions and recommendations.

METHOD OF STUDY

This is a Qualitative Descriptive Study which thoroughly examined the subject of automaticity. Thus, the basis for this study was the review of literature found in chapter two, which reported data from previous studies on automaticity.

The author reviewed fifty-three sources to develop the review of literature. All of this literature was combined to create a comprehensive overview of previous research on automaticity. The studies read and reported on in the review of literature revolved around three primary areas: 1) where automaticity is achieved, 2) theories surrounding automaticity, and 3) methods of attaining automaticity; therefore, Chapter two is divided into these three sections. From the abundance of information gathered and examined, deductions were reached combining the results of studies and data collected. None of the information in this study is really new or on the "cutting edge" or at the organized theory of creation, rather the study and data collected combined an original method of utilizing the existing information and comparing it to an alternative viewpoint at expense of the author.

Most of the information found in Chapter two originated from studies specifically related to automaticity, or skills needing to obtain automaticity. However, some of the information gathered had only small sections of the study devoted to automaticity. The information on automaticity exists in educational papers, articles and chapters of books on cognition and memory. No books were found solely on the subject of automaticity. Therefore, even though much information was found on automaticity, the lack of books devoted to the subject suggest that research on automaticity is in its infancy and/or it is not been considered important enough to devote an entire book.

DATA ANALYSIS

The study examined the numerous areas where automaticity has been used as a teaching or training strategy. From this knowledge a great deal of insight was gained on the various strategies utilized to obtain automaticity. These strategies can be transferred to a variety of areas. With the proper analysis of the function, as well as utilization of the systematic instructional design model, strategies were determined for utilization in training. Thus, Chapter four reports major findings and draws conclusions, provides recommendations and presents a model of automaticity, using a concrete example.

By utilizing the theories surrounding automaticity one could determine whether a task could become an automatic function. The characteristics of automaticity can assist one in differentiating between an automatic and controlled function. An automatic function can not be attained easily and some functions do not lend themselves well to automaticity, thus it is necessary to determine whether a task could ever attain automaticity, before instruction begins. Therefore, an in depth analysis of the function that is to be trained, is necessary. Chapter four will illustrate how such an analysis could be accomplished.

The established methods for attaining automaticity, can be utilized in many areas of human life. They are already being utilized in toilet training, walking, and self feeding of infants. Anyone who has ever taught these tasks to children, know first hand the difficulty involved in training them. However if a child of three years old can obtain automaticity, adults can obtain automaticity in many settings as well. Chapter four further summarizes the methods of attaining automaticity and develop a simple model of attaining automaticity for the reader to utilize in training.

Overall Chapter four utilizes the information from Chapter two and draws concrete conclusions related to the research questions stated in Chapter one. The information presented in Chapter four is utilized to provide a model for future researchers and practitioners to utilize when automaticity in training is required regardless of the variety of skills or learning domain.

Chapter 4

AUTOMATICITY MODEL

Chapter four reports a brief overview of the findings, conclusions and recommendations for this paper. Further, the author has provided a model for achieving automaticity. The chapter concludes by answering the research questions introduced in Chapter one, and provides recommendations for further study in the area of automaticity.

SUMMARY

This section summarizes the most critical data found on the subject of automaticity. Even though all of the literature presented is significant to the study of automaticity, some of the information gave the author deeper insight to solve the specific problem examined in this study.

Bryan and Harter's 1899 "Studies on the telegraphic language the Acquisition of a Hierarchy of Habits" is still one of the most critical "benchmark" studies done on automaticity. The results of this study revealed what is known as a plateau curve. A plateau occurs when the learning curve begins to taper off creating a plateau. "A plateau in the curve means that the lower-order habits are approaching their maximum development, but are not yet sufficiently automatic to leave the attention free to attack the higher-order habits. The length of the plateau is a measure of the difficulty of making the lower-order habits sufficiently automatic" (Bryan and Harter, 1899; 357). Mostly this study is significant, because it reveals the importance of learning lower-order skills before training for higher-order skills. It also shows the importance of breaking skills down into subskills and training each one individually.

"Cognitive Science and Military Training" (Halff, Hollan and Hutchins, 1986) is a critical piece of literature to this study primarily because it assess similar training issues to the type which exist in industry. This study reveals the necessity of achieving automaticity in military training, which most closely aligns with the importance of achieving automaticity in other fields as well. Halff, Hollan and Hutchins' work is most closely related to the problem of this paper, therefore it is used as a model for achieving automaticity elsewhere.

David Salisbury's 1990 "Cognitive Psychology and Its Implications for Designing Drill and Practice Programs for Computers" is much more significant in the study of achieving automaticity than its title might indicate. This study outlines methods of achieving automaticity through drill and practice programs for the computer. This article reveals the effectiveness of short intervals of practice rather than long durations of practice. The method of spaced intervals of practice has been verified to be critical through "Precision Teaching" which helps student increase endurance by building fluency (Binder, Haughton, and Van Eyk, 1990). Salisbury also outlines the significance of reviewing materials throughout the learning process, not just at the end of a lesson.

Each of these studies has contributed to the research questions, and the problem this paper addresses. To assist in accomplishing the task outlined in the problem, the author has developed a model for automaticity. The model is, not only a variation of the methods of achieving automaticity which already exist, but also combines the data which is significant to the study of automaticity.

MODEL *

The model of automaticity is broken down into two parts. First, the task must be analyzed to determine if it is appropriate to train to the level of automaticity. Second, a comprehensive strategy, to instruct the task, must be outlined which will utilize a variety of methods. This model is a prototype which can be used when training toward the level of automaticity .

I. Analysis

A thorough analysis of the task should indicate whether the task contains the characteristics where automaticity would be appropriate. Not all processes lend themselves well to automization, thus before training begins, the outcome of the training should be reviewed and a determination made of the characteristics of the task. The characteristics of automaticity will be described to assist in making this determination.

A. Analyze overall function

It is generally agreed that when an act has reached the level of automaticity it can be performed with little cognitive effort, thus giving the ability to carry on other functions simultaneously. Therefore a task can not be so complex that it utilizes the entire cognitive structure in order to accomplish it. The task should be performed continuously over a period of time, which could indicate that the task is accomplished continuously throughout the day or at a given time when appropriate. An automatic function can occur in any domain, utilizing the cognitive domain fully until the act becomes automatic. Automaticity is generally perceived to be most useful in procedural knowledge, otherwise known as knowledge of a process.

B. Determine specifics of the function

To continue the analysis, an exact determination of how the task is to be accomplished must be specified, because the procedure must be learned correctly, then mastered (Gagne, 1983). If the skill needs to be altered for any reason it would have to be done through extinction, and the entire process of achieving automaticity would need to be reversed and/or repeated. After obtaining automaticity the task is very difficult to alter. One must forget the previous task and begin again to train for automaticity of the new task. The task of obtaining automaticity is a very long and difficult process, therefore the adequate amount of time should be devoted to the process to achieve the desired results.

C. Break function down into subskills

Finally, the task selected to become automatic should be broken down into separate subskills which eventually binds them together to become one automatic function. These subskills are practiced individually, and each is a prerequisite for another, the skills eventually integrate together creating one skill, and attaining automaticity.

II. Strategy

There is much speculation on how automaticity is achieved. However, what is conclusive is, automaticity is obtained by utilizing a variety of methods and integrating them throughout the training duration with consistent practice. Throughout this practice, there are many microstrategies that can the utilized for the purpose of reaching automaticity.

A. Introduce the entire function

Initially the learner must be introduced to the entire function. This includes explaining why the function is important, how it is accomplished and the outcome of properly performing the task. This is to be an overview of the function, so the learner understands the association of the function with the goal. Even though it is important that the learner understand what is happening and how to perform the skill, it is suggested that the learner actually perform the skill initially, before fully understanding its intricacies. Consequently, in later training, the learner has a better idea of how to accomplish the skill.

B. Learn subskills individually

After the learner has performed the entire skill initially, the subskills will be presented individually and practiced. The learner should move to the next subskill before the previous one has attained automaticity. This is intended to assist the learner in attaching the next subskill with little difficulty. Thus, when all the subskills are combined, they can easily be formed into one task. When learning each subskill, the previous skill should be reviewed, these reviews test learners for previously learned items, while giving them a break from intense practice. Learning all of the subskills does not have to be done at one time, but rather at the learners pace; therefore, the training must have the capability of reviewing materials and resuming practice functions at any given time.

C. Practice entire function

Practice is of course the most well known method of attaining automaticity. However, practice must contain other aspects to be most effective. The practice must be consistent, always occurring the same way and in an environment which is similar to the setting in which the function will occur. There also needs to be a level of consistency in how the process will be practiced. Even though practice is one of the most important methods of obtaining automaticity, long durations of intense practice should be avoided. Rather, practice should occur in spaced intervals. Review materials should also be available to answer any questions that may occur as the function begins to obtain automaticity. Throughout the entire program consistent methods and realistic situations should be utilized to increase the effectiveness of the program.

This model can be utilized for a wide variety of functions, and with many forms of media. Some forms of media are more conducive to the special intricacies of training for automaticity. The computer can be highly effective in training for automaticity. The computer allows one to learn at their own pace. It can utilize a variety of learning strategies, and has the ability to let the learner practice a skill over and over. Although the computer is not recommended for all instruction, when appropriate it can be effective. Along with Computer Aided Instruction (CAI), is the progressive technology of Interactive Video instruction, which utilizes the capabilities of CAI and video training. An example of how Interactive Video can be utilized in training for automaticity, will be outlined, and the entire model will be demonstrated using the chopsaw, which is a machine found in the cabinet making industry, as an example.

EXAMPLE

Introduction

This example will combine the information previously discussed in this chapter combined with the authors' experience in industrial training. The process presented as an example for analysis is that of a chopsaw operator. The chopsaw is a machine that crosscuts wood into needed lengths for cabinet making. The operator must operate this machine while wasting as little wood as possible, thus obtaining high yield.

I. Analysis

An appropriate task analysis must be completed to build the foundation for achieving automaticity. This technique is consistent with systematic instructional design principles.

A. Analyze overall function

The first step is to determine if the characteristics for obtaining automaticity exist. Operating a chopsaw requires two skills, the actual physical skill of operating the saw, and the intellectual skill of determining where to make the appropriate cuts. A chopsaw operator continuously operates their machine throughout the day. This procedure can be somewhat confusing when first learning the machine, however, through observation of the machine and the process of operation, it eventually becomes a natural extension of the operators being. From this brief analysis one can deduce that operating a chopsaw has the primary characteristics of obtaining automaticity.

B. Determine specifics of the function

The next step is to determine, as specifically as possible, how to obtain automaticity with the desired outcome. On the chopsaw, the desired outcome is to obtain high yield from the wood. Yield is the amount of wood utilized in the final product. This can be accomplished by thoroughly analyzing where to make each cut, while insuring that it be free of defects; therefore, the operator must always look for defects in the wood, and make cuts where the least amount of usable lumber would be wasted. To reach this objective on the chopsaw, the wood must be checked for defects continuously throughout the process. This is done by flipping each board and checking both sides of the wood before each cut is made. If for some reason this step was be left out, and latter inserted, the learner would have to be retrained on the entire process. Safety is another consideration in the training of this machine, therefore all safety procedures must be adhered to and properly trained throughout the process.

C. Break function down into subskills

After determining the proper method to train the task, the entire task must be broken down into separate subskills. For the chopsaw, the first step would be to examine the board for defects. This is done by continuously flipping the board, and looking for defects. The next step is to determine where to make the cut. Appropriate cuts are made according to defects and needed lengths. Next, the cut should be made by operating the blade switch. The entire process is repeated until the board is completed. At this time the operator is required to record the cut board by pushing the counter, and continues with another board. Therefore the processes of actually cutting a board is broken down into four separate subskills.

II. Strategy

The strategy which was used in training for automaticity on the chopsaw utilized a variety of methods. An interactive video program was designed which explained the overall function of the chopsaw, as well as some of the more complicated functions of determining where to make the appropriate cuts.

A. Introduce the entire function

The learner will view the entire interactive program initially, thus learning about the chopsaw. The program will give a comprehensive overview of the function that is required and its importance in the overall production. After the program is viewed the learner is given a chance to initially try the skill. It is often necessary to perform a skill without total proficiency, which gives the learner the opportunity to fully understand the skill. Once the learner has had some time to practice, he/she should go through the program again and concentrate on the individual subskills of the function. Interactive video gives the learner the capability to review all or part of a program at any time.

B. Learn subskills individually

The program will then be broken down into separate sections according to subskills. After each section, question will need to be answered regarding the previously given information. At this point computer practices are presented which are a realistic simulation of the task. Then a comprehensive example will be given on video. The example will be stated differently several times to accommodate different learning styles. If necessary, the learner can quit the program and pick up where he/she left off at any time. After the interactive program the learner is able to practice each subskill individually, going to the next subskill at the appropriate time.

C. Practice the entire function

When the learner feels comfortable, he/she can begin to work on the machine. Practicing at spaced intervals and reviewing material when it is necessary. Even though the learner may take up to a year to develop automaticity, the foundation is set to achieve automaticity more efficiently and accurately.

There are many ways in which automaticity can be achieved, this example just outlines one method which can be utilized. The key to obtaining automaticity is properly analyzing the function and utilizing consistent practice through a variety of methods.

RESEARCH QUESTIONS

The research questions poised in chapter one are repeated, followed by data and research evidence uncovered by the study.

1. Can the principles used to teach automaticity in education be used to teach automaticity in training? Findings: The principles that are used to teach automaticity in education, crossover nicely to training. Automaticity can be achieved through the training function, thus the principles and strategies which teach automaticity in education can be utilized in training. However, modifications have to be made to fit the task. Not all functions are appropriate to train to automaticity, so the model previously presented is intended to help determine if automaticity training is appropriate for the skill.

2. Are there principles of automaticity used in training now, if so where and how? Findings: Automaticity is not utilized exclusively in education, and has been found to exist in training. Halff, Hollan and Hutchins have discovered the necessity for training for automaticity in the military. Using the military as a model gives rise to identifying the need for obtaining automaticity in other training environments as well. This author's belief that the characteristics of and need for automaticity are found in business and industry, but automaticity is achieved haphazardly rather than by design, resulting in the retraining of skills several times; therefore, a well

defined model of designing training to achieve automaticity is imperative.

3. What methods of training best bring learners to the level of automaticity? Findings: Throughout this paper the method for obtaining automaticity has been a paramount issue. The model outlines how automaticity can be achieved, and indicates what methods of training best bring learners to the level of automaticity. Summarizing, automaticity is achieved by thoroughly analyzing the task, and utilizing a comprehensive strategy for learning that task. Both the analysis and the strategy offer examples and are outlined in the model, as well as an example of utilizing this model.

4. Can automaticity training be used in the psychomotor domain of learning? Findings: Automaticity is a function that often utilizes two domains of learning simultaneously. The domains that lend themselves best to the characteristics of automaticity are the psychomotor and the cognitive domain. However, the affective domain can be a major factor in training for automaticity as well. Therefore, automaticity can exist in any domain of learning.

CONCLUSION

An appropriate conclusion to a descriptive study such as this, rests on an reexamination of the overall problem stated in Chapter one which was: Can the concept of automaticity be utilized and taught utilizing the training function in a similar manner as it is done in education? As previously stated, all the research questions asked where answered in the affirmative. Therefore, the overall question of whether automaticity can be obtained through the training function is also affirmative. Automaticity can be obtained through training, however, it may take more time. This paper outlined how automaticity could be achieved, through both a model and an example. This should diminish any doubt regarding whether automaticity can be obtained through training.

RECOMMENDATIONS

This model was designed not only to be used in training an audience to the level of automaticity, but also to spur interest in automaticity. The model introduced in this chapter is based solely on the research done for this paper. It is the hope of this author that this model is challenged and even improved upon. It can be utilized as a prototype for designing instruction for automaticity and the results documented, thus the research done on automaticity can continue into the next century.

The author recommends further research in the study of automaticity. The research on automaticity should focus on how it is achieved. perhaps resulting in methods being tested and evaluated. Finally, the author recommends further information be written regarding automaticity and published in training related periodicals. Automaticity training should be introduced to trainers in industrial settings. Overall research on automaticity must continue in order for the methods of attaining automaticity to solidify into one concrete solution.

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