Information Processing Model

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Research Paper submitted for

CI 703 Models of Teaching

at Marshall University

in partial fulfillment of the requirements

for the degree of

Doctor of Education

in

Educational Leadership

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South Charleston, West Virginia

2012

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# Introduction

Within the framework of this model, the emphasis is on the way human beings process information, make decisions, and develop intellectual capacity (Joyce, Weil, & Calhoun, 2009). Learning within this model represents the process of gathering data and organizing it into mental schemata (Kandarakis and Poulos, 2008). The teachers following this model assume an active stance in seeking ways to help students process information to become more powerful learners as they provide them with tools for lifelong learning. The process of gathering, organizing, and storing information is a vital component of instruction. Learning within the information processing model is characterized by flexibility allowing individuals to build a mental schemata to apply information to a variety of generalizable concepts rather than sticking to defined behaviors advertised by the behaviorist approach.

# Delimitations

General research on information processing models was reviewed. The study focused on the contributions of the theorists to the development of the models, the structure of the instructional delivery, and weaknesses and strengths of each model. Within the framework of information processing models, only inductive learning, the picture-word inductive model, and inquiry learning were evaluated. Specific classroom examples were not reviewed in this paper.

# Methods

In order to gain a comprehensive understanding of the information processing model role and its applicability in the classroom, various databases and journals were reviewed in regards to the research leading the development of the information processing model and its use of memory storing concepts to process information. The syntax and conceptual framework were evaluated in regard to inductive, picture-word inductive, and inquiry learning. Finally, the strengths and weaknesses of each model were identified.

# Review of the Literature

The review of literature will focus on the general outline of the information processing model and related conceptual framework. Following the general introduction to the model, each instructional strategy will be discussed in detail.

# Information Processing Model

Information processing models rely on the memory store functions involved in the cognitive processes: sensory memory, working memory, and long-term memory. Hall (2009) identifies sensory memory as a sensory buffer that briefly stores information and likens the short term memory to the file on the computer before it is saved. Long-term memory is analogous to the stored information on the hard drive or the cloud.

Eggen and Kauchack (2007) describe the memory stores and outline the functions of each store. Sensory memory stores information for one to four seconds before it becomes a part of working memory or is lost forever. The sensory memory has an unlimited capacity for information but is very limited in its capacity to store it. Therefore, information processing strategies aim at meaningful retention of information through spiraling curriculum and repetition in order to transfer the information form sensory memory to working memory.

The important aspect of the sensory memory is in its ability to help the processing memory attach meaning to the information received for the second-short span of time (Eggen and Kauchack, 2007). Sensory memory processes bear meaningful implications for the instructional processes, as the teachers using this model make meaningful connections between new information, background knowledge, and student connections to real life. The students are more likely to pay attention to the information if it has an interesting feature and helps them active a known pattern. During this phase of information acquisition, it is important to direct student attention to the information, as discarding the information prevents students from seeing it as important and, therefore, storing it in their working memory.

Working memory is capable of storing information for ten to twenty seconds and is also quite limited in its capacity and duration (Eggen and Kauchack, 2007). There is no definite information in terms of the storing capacity of the working memory. However, Eggen and Kauchack (2007) identify the concept of the cognitive load and the student ability to chunk the information as determinants of the storing capacity of the working memory. Even though the information is stored longer in the working memory, it is lost if the students do not link it to the content and assign the new information perceptual importance. Students make connections to content based on building links to prior knowledge. As they get older, they are able to learn more by making connections to content based on a wide base of background knowledge.

Long-term memory is the final memory store of the information (Eggen and Pauchack, 2007). The information gets stored permanently through rehearsal, after students meaningfully chunk the information. In comparison to the previously discussed memory stores, long-term memory has virtually unlimited capacity to store and recollect information. The types of knowledge retained by the students can be identified as declarative and procedural. Additionally, the tracks used to process the knowledge can be defined as visual track and a verbal track. Paivio (1990) promoted this Dual Coding Track theory, which emphasizes the instruction that facilitates the acquisition of information via both tracks in order to increase retention and recall over time. Craik and Lockhart (1972) used similar principles to identify the levels-of-processing theory proposing that learners use various levels of elaboration to process information from perception to attention, labeling, and meaning.

Hilda Taba’s work is also important to note in regard to the development of information processing model (Krull & Krum, 1996). Taba introduced notions of multiple educational objectives and four distinct categories of objectives: basic knowledge, thinking skills, attitudes, and academic skills, attributing teaching/learning strategies to each and considering separately the selection and organization of instructional content and strategies of learning. There are many ideas underlying Taba’s curriculum model. In her approach such notions as ‘spiral’ curriculum, inductive teaching strategies for the development of concepts, generalizations and applications, organization of content on three levels (key ideas, organizational ideas and facts), and her general strategy for developing thinking through the social studies curriculum significantly influenced curriculum developers during the 1960s and early 1970s.

Taba believed that social processes were not linear (Krull & Krum, 1996). Therefore, they could not be modeled through linear planning. Learning and development of personality were not be considered as one-way processes of establishing educational aims and establishing specific objectives from an ideal of education proposed by some authority. Taba believed that it was impossible to establish a concrete education plan with rigid goals and more specific objectives. Taba believed social institutions are more likely to be effectively rearranged if a well-founded and coordinated system of development from bottom to top could be used (Krull & Krum, 1996). Taba also believed that any changes and learning underlying them would be easier to achieve if they were spread on the periphery, with their gradual application throughout an organization. Taba also stated that the development of new curricula and programs was more effective if it was based on the principles of democratic guidance and on the well-founded distributions of work. The emphasis was on partnerships based on competence not on administration

Information processing instructional models have a long history and are based on cognitive learning theory. These models are consistent and apply cognitive approaches to learning intuitively, using knowledge retention principles. However, in their basic connection to computer processing models, information processing models forego emphasis on social context and human emotion and their contribution to learning. The information processing approaches discussed in this paper are not devoid of social aspect of learning and emotion. They build on student prior knowledge and value collaboration to facilitate student learning (Weil, Joyce, & Calhoun, 2009).

## Inductive Learning

Foundations of inductive teaching and learning build on the premises of constructivism holding that individuals actively construct and reconstruct their own reality to make sense of their experiences (Prince & Felder, 2006). The works of Piaget, Dewey, and Vigotsky contributed to the model in terms of content and the concept that experiences presented to students should be familiar concepts to them, so that students can make connections to their existing mental schemata (Bransford et al., 2000). Inductive learning and teaching also borrow from cognition research that stresses that new learning incorporates transfer of information based on previous learning. Inductive learning is most effective when it involves *diagnostic teaching* that allows teachers to evaluate what students think about the information under study and help them identify misconceptions through situations that will facilitate their readjustment of ideas as they move on through instruction.

Joyce, Weil, and Calhoun (2009) state that humans conceptualize at all times, comparing and contrasting various chunks of information every day. Therefore, teachers using inductive thinking learning approaches create environments where the natural human ability to form and use concepts is nurtured to help students consciously develop their skills in doing so. Inductive teaching and learning builds on a concept established in education psychology stressing that people are more motivated to learn things that they view as needed to know (Prince & Felder, 2006).

The inductive model focuses on helping students collect information, evaluate its attributes, classify this information into categories, and engage in active interaction with attained concepts (Prince & Felder, 2006). Teachers follow certain guidelines to craft appropriate learning environments carefully. These guidelines help teachers and learners establish learning communities as they create data sets and engage in learning tasks of classification and reclassification of categories and the subsequent generation of hypotheses.

Teachers establish the focus of the lesson to help students concentrate on a domain where they need to become proficient without restricting their full abilities to generate ideas (Joyce, Weil, & Calhoun, 2009). The authors then describe the stages through which students progress to hypothesis generation. During this stage of focus establishment, teachers provide information and ask students to study the attributes of items in certain sets, such as statistical data from countries or the states. After the focus is established, the teachers move on to the conceptual control stage where students develop conceptual understanding of the information under study. At this stage, the students would categorize the statistical data in terms of its similarities and differences. At the final stage of the lesson, the students are guided through a series of activities that help them convert their conceptual understanding into skill. Therefore, students would generate hypotheses based on their previously identified statistical data categories.

The inductive process involves continuous collection and evaluation of information and construction of ideas (Joyce, Weil, & Calhoun, 2009). Students generate hypotheses to understand the relationships between their identified concepts and apply their understandings to the development of skills that have practical application. The teacher’s role is essential in guiding student interaction with ideas and information, as the domains formed during their work are flexible and can be change as the students develop further skill in manipulating the concepts.

## Picture-Word Inductive Model

The picture-word inductive model (PWIM) is grounded in research on literacy: how children develop literacy in general, and in certain content areas (Joyce, Weil, & Calhoun, 2009). The building of the vocabulary is an essential part of literacy, and since most vocabulary distinctions develop in children before the third grade, early vocabulary acquisition instruction is vital to ensure solid basis for literacy (Biemiller & Slonin, 2001). PWIM has been designed to address the needs of primary-level beginning readers or older beginning or early-stage readers (Joyce, Weil, & Calhoun, 2009). According to Calhoun (1999), this model has several specific purposes. It can be used with a variety of student groups to help them inquire about words, build their sight-reading and writing vocabulary, and use observation and evaluation skills to discover phonetic and structural principles in reading, writing, and comprehension. PWIM is an inquiry-based language arts strategy that uses pictures of familiar words or actions to help students develop their listening and speaking vocabularies.

The PRIM structure incorporates cycles of inquiry lasting for several weeks (Weil, Joyce, & Calhoun, 2009). As this model approaches the development of sight vocabulary directly, the students learn to read and spell the words shaken out of the picture that is presented at the beginning of the PWIM cycle. The emergence of the final, illustrated picture-word dictionary in the form of the annotated picture provides students with a storybook and a beginning point for the discussed vocabulary acquisition. During the next phase, students are provided with large word cards to use during the group instruction as they work on practicing the words. Students also use the cards to classify the words into phonetic or content properties, compose sentences, and ultimately build concepts about the conventions used in language as they connect sounds to the print forms.

The PWIM model builds on the premise that reading and writing are naturally connected and are learned simultaneously (Stotsky, 1983). Their interdependent use can effectively advance language growth in children and can be incorporated not only into language arts curriculum for beginning readers but also into the social studies curriculum for more advanced reading acquiring academic vocabulary (Weil, Joyce, & Calhoun, 2009).

## Inquiry-Based Learning

Inquiry learning begins when students are faced with questions to answer, problems to be solved, or a set of observations or data to be explained (Prince & Felder, 2006). Through this instructional method, students learn to formulate substantial questions, collect appropriate evidence, gather and interpret data, draw conclusions, and identify their importance (Lee, 2004). Lee points out that inquiry learning and teaching is consistent with interactive lecture, simulation, service learning, or independent study. During inquiry learning, the instructor serves as a facilitator, working with student groups based on the need and addressing whole group issues if necessary. Michaels et al. (2008) describe inquiry teaching as just-in-time approach to generate new ideas and provide support based on a continuous formative assessment of student work.

Inquiry learning incorporates a variety of strategies that differ significantly from each other. Abrams, Southerland, and Evans (2008) describe inquiry teaching as a developmental process, guiding students incrementally from more structured exposure to inquiry to a greater independence from being told the answers. Abrams, Southerland, and Evans identify four common inquiry levels: confirmation, structured, guided, and open. During confirmation level of inquiry, students are provided with hands-on experiences with a goal of arriving to the same results after working through this experience. During the structured inquiry, students identify their own ways of finding solutions to the problem while following the same essential question as the rest of the group and provided with an outline as to how they can solve it. Guided inquiry is allows students to develop their own questions and strategies as they work on an inquiry topic or a theme. Open inquiry is the least teacher-structured activity during which students identify and develop projects that interest them.

# Applicability of the Model to Preferred Teaching Style

As a language arts teacher, I struggled to implement continuous inquiry processes with students until I understood the nature of meaningful language arts instruction in its practical application to reading and writing experiences in literary and nonfiction environments. As a middle school language arts teacher, I did not use PWIM as one of my instructional methods. Even though I had a lot of struggling readers, using a picture dictionary for them would have to be supplemented by other age-appropriate means of scaffolding and enrichment.

Inductive learning strategies were frequently used in my instruction, as they helped students see the concepts as they classified adverbial phrases or types of conflict based on previously read materials. The experiences built within the framework of inductive learning were meaningful to students as they capitalized on their innate need to find meaning behind the slew of vocabulary, literary elements, and writing approaches.

# Conclusions

Information processing models of teaching capitalize on the human need to conceptualize information around them. Constructivist and cognitive bases of learning support this model of teaching, with students proceeding through the stages of classifying information in meaningful chunks, building on previously acquired information, and connecting previous learning to new learning by making meaningful associations.

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