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Building an Instructional Model for the High School of the 21st Century

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Abstract

High schools are the last frontier of change in the K-12 educational setting. In order to meet the needs of today's students, teachers must create systemic change. This research studied ways to build an instructional model for high schools of the 21 st century. The sources were selected from published literature about brain research, lesson design. school reform and studies of education systems between countries. The design of an instructional model for high schools was developed, using the research from literature reviews. Teaching methods, not teachers are at the heart of this reform.

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Introduction

High schools are the last frontier for change in the K-12 educational setting. With the significant emphasis on improving education in the high schools, there is a need to utilize the current research and information on brain-compatible instruction, meaningful real-world application, research-based instructional design, and the implementation of lesson study to build a workable instructional model. The research presented will suggest ways that teachers can improve the relevance of their instructional design, improve a student's ability to learn, and increase the interest in learning through the use of research-based strategies and initiatives in the classroom.

There is an abundance of information available on various ways to improve instruction, but much of this information is presented in isolation. This research will attempt to integrate the information and create a model to use when designing instruction for the classroom, using the latest brain-compatible data, combined with other research-based suggestions for improvement.

Methodology

This research will incorporate the most recent information on brain-compatible initiatives, coupled with the recommendations for high schools of the future. It will identify ways to improve instruction, assuring that the materials make sense and have meaning, and move to lesson design and ways to formulate relevant connections with information. The research materials will be selected from reliable sources and will be discussed as they weave the support and identification of the necessary components for reform of the high school setting and instructional methods.

Analysis and Discussion

The information for high school reform comes from a partnership in 1996, between the Carnegie Foundation for the Advancement of Teaching and the National Association for Secondary School Principals on the high school of the 21st century entitled Breaking ranks: Changing an American institution. This report identified nine purposes that represented their vision for this nation's high schools and frame the recommendations for the report. The Carnegie report (1996) purposes are:

I. High school is, above all else, a learning community and each school must commit itself to expecting demonstrated academic achievement for every student in accord with standards that can stand up to national scrutiny.

II. High school must function as a transitional experience, getting each student ready for the next stage of life, whatever it may be for that individual, with the understanding that, ultimately, each person needs to earn a living.

III. High school must be a gateway to multiple options.

IV. High school must prepare each student to be a life-long learner.

V. High school must provide an underpinning for good citizenship and for full participation in the life of a democracy.

VI. High school must play a role in the personal development of young people, as social beings that have needs beyond those that are strictly academic.

VII. High school must lay a foundation for students to be able to participate comfortably in an increasingly technological society.

VIII. High school must equip young people for life in a country and world in which interdependency will link their destiny to that of others, however different those others may be from them.

IX. High school must be an institution that unabashedly advocates in behalf of young people.(p.2)

The nine purposes of the recommendations suggest some definite modifications in the way high schools are organized and instruction is designed. The report identifies a significant need to change the way high school students are educated. The Carnegie report (1996) goes on to say:

> We believe that improvement requires high schools to alter themselves and so we present this vision of the future, as one that preserves what is best while unapologetically offering new initiates. Six main themes thread their way through the pages of this report, emphasizing that better education depends on personalizing the high school experience for students, lending coherency to their education, organizing time differently, using technology at every opportune point, revitalizing the ongoing professional education of teachers and administrators, and enhancing leadership at every level at which it can affect teaching and learning:
>
> <u>Personalization</u>—High schools must break into units of no more that 600 students so that teachers and students can get to know each other better. Then, teachers should use a variety of instructional strategies that accommodate individual learning styles and engage students. This will be helped by every student having a Personal Adult Advocate and a Personal Plan for Progress.
>
> <u>Coherency</u>—High schools should be clear about the essentials that students must learn to graduate. Disciplinary departments should be reorganized so that subjects are more closely linked and schools should align what they teach with what they test. In the end, learning must make sense to students in terms of the real world

test. In the end, learning must make sense to students in terms of the real world and the application of what they know.

Time—Teaching and learning need room for flexibility. High schools must abandon or revise the Carnegie unit so that they no longer equate seat time with learning. Furthermore, schools should operate 12 months a year and full-time teachers should not be responsible for more than 90 students a term so that they can give more attention to individual students.

Technology—High schools must develop a long-term plan for using computers, CD-ROMs, videodiscs, and other technologies in all aspects of teaching and learning. Toward this end, each high school must have a technology resource person to consult with and assist the staff. The curriculum should be conveyed through technology and teaching strategies should employ technology whenever appropriate.

Professional Development—Educators cannot improve high schools without the proper preparation to take on new roles and responsibilities. Their education in teacher colleges should equip them for changing demands in teaching and learning, and continuing inservice education must have a valued place in their day-to-day professional lives once they are on the job. Each educator in the school, including the principal, should have a Personal Learning Plan.

Leadership—Good intentions will come to naught unless people step forward to lead high schools into the future that is envisioned on these pages. Leadership in each high school must begin with the principal, but must include teachers, students, parents, school board members, the superintendent, and community residents who contribute to making school better. (p.5)

It is with this framework, additional research was sought to complete the teaching and learning model, outlined in the Carnegie report. The next step was to identify the learner and the learning mode that the high school student possesses. The students of today are not entering the classroom with the same brain as they had 40 years ago. Sousa (1995) states:

> Every day teachers enter their classrooms with lesson plans, experience, and the hope that what they are about to present will be understood, remembered and useful to their students. Yet, the extent that this hope is realized depends largely on the knowledge base that these teachers use in designing those plans and, perhaps more important, on the instructional techniques they select during the lessons. (p.xiv)

To know which instructional techniques to use, it is helpful to gain an understanding of the human brain. There have been many attempts to identify how the brain is organized and how the brain works. This research will identify the different general functions of the brain: the cerebrum, the cerebellum and the brain stem. With the description of each function, an educator can understand the linkage between the physical brain functions and the impact on learning, in essence, the relationship between the brain and the mind (See Appendix A).

The cerebrum is the largest of three areas, representing over 80 percent of the brain by weight. It is divided into two halves that run the length of the cerebrum. The cerebrum is where the nerves from the left side of the body cross over to the right hemisphere, and those from the right side of the body cross to the left hemisphere. A thick cable, the corpus callosum, connects the two halves and allows each half of the cerebrum to communicate with each other and coordinate the activities in the brain.

The cerebrum controls thinking, memory, speech and muscular movement. The limbic system lies deep within the cerebrum and coordinates with emotional responses. Its placement between the cerebrum and the brain stem permits the interplay of emotion and reason.

The hippocampus, within the cerebrum, plays a major role in consolidating learning and converting information from working memory to long-term storage. It constantly identifies information relayed to working memory and compares it to stored experiences. This process sometimes takes weeks, but this structure is essential for meaning.

The amygdala is attached to the end of the hippocampus, and plays an important role in emotions. The amygdala encodes information in an emotional message, when information is transferred from working memory to long-term storage. The emotional message is often recalled whenever the memory is recalled. Emotions play an important role in cognitive learning.

The second part of the brain, the cerebellum is located just below the rear part of the cerebrum. The cerebellum is the area that coordinates every movement by monitoring impulses from nerve endings in the muscles. Although it does not initiate anything, it modifies and coordinates commands to swing a golf club, smooth a dancer's footsteps, and allow a hand to bring a cup to the lips without spilling its contents. The cerebellum may also store the memory of rote movements, such as touch-typing and tying a shoelace. This area of the brain is important in laying pathways to long-term storage.

The third part of the brain is the brain stem. Of the 12 body nerves that go to the brain, 11 end in the brain and are the center of sensory reception and are where vital body functions, such as heartbeat, respiration, body temperature, and digestion are monitored and controlled. The brain stem also houses the reticular activating system (RAS), or the perceptual register, which plays a significant role in determining what information is learned.

The identification and information about the three parts of the brain, helps us to understand how learning strategies fit into brain research. Sousa (1995) has developed a model for instruction, that identifies the process that information goes through, once perceived through the individual's senses. The process is called the Information Processing Model (See Appendix B). "Knowing how the human brain seems to process information and learn can help teachers plan lessons that students are likely to understand and remember"(Sousa, 1995,p.8).

This Information Processing Model has six components; the senses, the perceptual register, the short-term memory, the working memory, the long-term memory and self-concept. To identify this processing model more completely, each component will be described in further detail.

The first component is the senses. Our brain takes in more information from our environment in a single day than the largest computer does in years. Although Sousa (1995) speaks of five senses, Olsen (1995) identifies 19 senses that can stimulate the learner's attention. The senses do not contribute equally to our learning, however. Over the course of our lives, sight, hearing and touch contribute to about 95 percent of all new learning.

Our senses constantly collect bits of information from our environment, at an average of 40,000 bits per second. Of course, the stimuli must be strong enough for the senses to record them, so some stimuli are not identified. "The 40,000 bits of data per second is an average count over the course of a day. This number will be higher if you are deeply involved in a multi-sensory learning experience and lower if you are in an unstimulating environment" (Sousa, 1995,p.10).

The next component of Sousa's Information Processing Model is the perceptual register. This acts as a filter for information and directs sensual stimuli to the appropriate places. The technical name for the perceptual register is the reticular activation system (RAS).

The perceptual register is drawn in Sousa's Information Processing Model as the side view of slats, as in Venetian blinds. It monitors the strength and nature of the sensory impulses and, in just milliseconds, uses the individual's experience to determine the data's degree of importance. Most of the data signals are unimportant, so the perceptual register blocks them and they drop out of the processing system. Once the data signal is dropped out, it stays out. Out is out!

The perceptual register blocks repetitive stimuli, allowing your conscious brain to focus on more important things. This process is called perceptual filtering. This occurs all the time, and we do not know it is happening.

The third component was initially called short-term memory, but in a presentation by Sousa on January 18, 2000, he stated that his short-term memory component had been renamed to immediate memory, because many individuals use the term "short-term memory" for other definitions. Sousa (1995) describes the process:

> If the sensory data are important, or if the perceptual register becomes overloaded, the data are passed on to the first of two temporary memories, called the [immediate] memory. If you took a psychology course more than a decade ago, you learned we had two memories—one short-term (temporary) and one long-term (permanent) memory. The idea that we seem to have two temporary

memories is recent. It is a way of explaining how the perceptual register deals with an overload of sensory data, and how we can continue to process sensory stimuli subconsciously for many seconds beyond the perceptual register's time limits. (p.11)

These two temporary memories are called the immediate memory, which acts simply as an extension of the perceptual register, and working memory, where conscious processing occurs. When older literature discusses short-term memory, they are describing working memory.

The immediate memory area is represented in Sousa's Information Processing Model as a clipboard, a place where the learner puts information briefly until they make a decision on how to dispose of it. The immediate memory operates subconsciously and holds data up to about 30 seconds. The individual's experiences determine its importance; positive experiences will rank higher in importance than negative experience. If the stimulus is of little or no importance within the time frame, it drops out of the system - and again out is out.

Working memory is the second temporary memory in Sousa's Information Processing Model and the place where conscious, rather than subconscious, processing occurs. The model identifies working memory as a worktable, a place of limited capacity where we can build, take apart, or rework ideas for eventual storage somewhere else. When something in is working memory, it generally captures our focus and demands our attention. This processing can be revisited often, if information is unresolved.

Working memory can handle only a few items at once. This functional capacity changes with age. The capacity of working memory increases as one passes through major growth spurts in cognitive development.

Preschool infants can deal with about two items of information at once. Pre-adolescents can handle three to seven items, with an average of five. Through adolescence, further cognitive expansion occurs and the capacity range increases to five to nine, with an average of seven. For most people, that number is constant throughout their lives.

Changes in Capacity of Working Memory with Age			
Appropriate Age Range in Years	Capacity of Working Memory with Age		
	Minimum	Maximum	Average
Less than 5	1	3	2
Between 5 and 14	3	7	5
14 and Older	5	9	7

(Sousa, 1995, p.13)

The time that an individual can process information on that worktable is dependent on the age of that individual. Pre-adolescents' processing time is 5 to 10 minutes, and for adolescents and adults, 10 to 20 minutes. These time frames are contingent on the attention given to the information. An adolescent (or adult) normally can process an item in working memory intently for 10 to 20 minutes before fatigue or boredom with that item occurs and the individual's focus drifts. In order to continue the focus, change must occur in the way an individual is dealing with the item. This is where the teacher can change the stimuli and the mode of processing the information – change to physically using it, or making different connections to other learnings, or putting this information in real-world contexts. If something else is not done with the item, it is likely to drop from working memory, which means out is out. Some items can remain in working memory for hours or perhaps days. These items might be a troublesome family or work decision that needs continued consideration. These items can remain in working memory, continually commanding some attention and, if of sufficient importance, interfere with our accurate processing of other information. But generally most items have that 5-15 minute widow of opportunity to process and move to long-term storage.

So, which items in working memory should move to long-term storage and which items might drop out of the system? "This is an important decision because we cannot recall what we have not stored. Yet teachers teach with the hope that students will retain the learning objective for future use. So, if the learner is ever to recall this information in the future, it has to be stored"(Sousa, 1995, p.15).

The criteria used to determine what gets stored answers the following two questions. "Does this make sense?" and "Does this have meaning?" Sousa (1995) explains:

> "Does this make sense?" This question refers to whether the learner can understand the item based on experience. Does it "fit" into what the learner knows about how the world works?
>
> "Does it have meaning?" This question refers to whether the item is relevant to the learner. For what purpose should the learner remember it? ...Whenever the learner's working memory decides that an item does not make sense or have meaning, the probability of it being stored is extremely low. If either sense or meaning is present, the probability of storage increases significantly. If both sense and meaning are present, the likelihood of storage is very high. (p.16)

Meaning has the greater impact on the probability of moving an item into long-term storage. It is important to make those connections with the learner that makes sense and has meaning, but teachers spend much more time on the information "making sense" than if the information "has meaning."

In order to work with sense and meaning, the teacher also needs to be aware that timing of the learning experience is everything. Sousa (1995) has identified the primacy-regency effect. This phenomenon impacts the processing of information as much as sense and meaning does (See Appendix C). "During a learning episode, we remember best that which comes first, second best that which comes last, and least that which comes just past the middle" (Sousa, 1995, p.38). This is significant information for the teacher in regard to lesson design. A teacher needs to teach new information during the first 20 minutes (prime-time 1) of a 40-minute class period, use the down-time, approximately 8-10 minutes, for guided practice, and use the last 10-12 minutes for closure (prime-time 2). When the primacy-regency effect is paired with adolescent time for processing, approximately 10-20 minutes, before fatigue or boredom sets in—the teacher can get more prime-time by breaking the lesson into two 20-minute segments. The chart below explains:

Average Prime and Down-Times in Learning Episodes				
	Prime-Times		Down-Times	
Episode Time	Total Number of Minutes	Percent of Total Time	Number of Minutes	Percent of Total Time
20 minutes	18	90	2	10
40 minutes	30	75	10	25
80 minutes	50	62	30	38

(Sousa, 1995, p.42)

The primacy-regency effect can have a tremendous impact on the prime use of time in a learning experience. Teachers can optimize the learning when they structure their class time for the highest learning impact. Teachers need to prepare their learning episodes in modules of 20-minute segments. The key to optimizing learning, like all other learning experiences, requires that each learning episodes makes sense and has meaning.

The opportunity for guided practice is necessary for the learner to move the information from working memory to long-term storage. Down-time should be taken as seriously as prime-time. Sousa (1995) reviews the Madeline Hunter (1982) model. For practice to improve performance, three conditions must be met:

1. The learner must have all the knowledge necessary to understand the options available in applying the new knowledge or skill.
2. The learner must understand the steps in the process of applying the knowledge to deal with a particular situation.
3. The learner must be able to analyze the results of that application and know what variables need to be manipulated to improve performance in the future. (p.44)

In addition to Hunter's (1982) model, Sousa (1995) continues with additional criteria for the down-time to become efficient. Teachers help learners meet conditions when they:

- Start by selecting the smallest amount of material that will have the maximum meaning for the learner.
- Model the application process step-by-step.
- Insist that the practice occur in their presence over a short period of time while the student is focused on learning.
- Watch the practice and provide the students with prompt and specific feedback on what variable needs to be altered to correct and enhance the performance. (p.44-45)

The use of guided practice during down-time allows the learner to move the information from the working memory to long-term storage. Once the information is stored, it can be retrieved for later use. Guided practice does not make perfect, guided practice, during down-time in the learning episode makes permanent.

The fifth component of Sousa's Information Processing Model is long-term storage, which occurs when the hippocampus encodes information and sends it to one or more long-term storage areas. This encoding process takes time. Sousa (1995) explains:

> While learners may seem to have acquired new information or skill in a lesson, there is no guarantee that there will be permanent storage after the lesson. How do we know if retention has occurred? If the student can accurately recall the learning after a sufficient period of time has passed, we say that the learning has been retained. Since research on retention shows that the greatest loss of newly-acquired information or a skill occurs within 18-24 hours, the 24-hour period is a reasonable guideline for determining if information was transferred into long-term storage. If a learner cannot recall new learning after 24 hours, there is a high probability that it was not stored and, thus, can never be recalled. (p.18)

The way the lesson is presented also impacts the likelihood of retention. The more involvement the student has in the learning activity, the more likely the student will be able to recall the information. Sousa (1995) identifies the average percentage of retention of material after 24 hours for each of the following instructional methods:

Method of Instruction	Average Retention Rate after 24 Hours
Teach Others/Immediate Use of Learning	90%
Practice by Doing	75%
Discussion Group	50%
Demonstration	30%
Audio-Visual	20%
Reading	10%
Lecture	5%

(p.43)

The teacher needs to design the instructional materials carefully to increase the likelihood that materials will move from the immediate memory to working memory and then to long-term storage. Actively involving the student in the learning process is imperative.

The cognitive belief system is the framework for the last component of Sousa's Information Processing Model. The cognitive belief system is the total of all that is in our long-term storage areas.

The cognitive belief system is shown in the Information Processing Model as a large triangle extending beyond the long-term storage areas (file cabinets). This illustration reminds us that the thoughts and understandings that arise from the long-term storage data are greater than the sum of the individual items. One significant quality of the human brain is its ability to combine individual items in many different ways. This number grows geometrically as we acquire more knowledge.

A person's self-concept carries significant weight in the cognitive belief system. It uses the collective experiences and memories stored in long-term storage to facilitate learning. "While the cognitive belief system portrays the way we see the world, the self-concept describes the way we view ourselves in that world" (Sousa, 1995, p.20).

The self-concept is represented in the model as a face and is placed at the top of the triangle to emphasize its importance. Self-concept is used here as a neutral term that can run the gamut from very positive to very negative. "The face on the diagram has a smile, indicating a positive self-concept, but for some people, the face might have a frown since they may not see themselves as positive beings in their world. Emotions play an important role in forming a person's self-concept" (Sousa, 1995, p.20).

Our self-concept is shaped by our experiences. Some of our experiences raise our self-concept, while other experiences lower our self-concept. Costa and Kallick (2000) explain the value of the cognitive belief system:

> Children develop cognitive strategies and effort-based beliefs about their intelligence—their habits of mind associated with higher-order learning—when they continually are pressed to raise questions, accept challenges, find solutions that are not immediately apparent, explain concepts, justify their reasoning, and seek information. When we hold children accountable for this kind of intelligent behavior, they take it as a signal that we think they are smart, and they come to accept this judgement. (p.4)

These experiences produced strong emotional reactions that the brain's amygdala encoded and stored with the cognitive event. These emotional cues are so strong that the learner often re-experiences the emotion each time they recall the event. That's why a person can visualize a Thanksgiving celebration when they smell roasted turkey.

The Information Processing Model by Sousa (1995) assists the teacher in preparing lessons for students. How the learner responds to new information is directly related to the ability to make sense and meaning of the new information. The self-concept component of the Information Processing Model cannot be underestimated.

Sousa (1995) explained that the perceptual register and immediate memory use experiences as the criterion for determining the importance of incoming data to the individual. If the learner is in a new learning situation and their experience signals the perceptual register and immediate memory that prior encounters with this information were successful, then the information is very likely to pass along to working memory. The learner now consciously recognizes that there were successes with this information and focuses on it for further processing. But if experiences produced failure, then the self-concept signals the perceptual register to block the incoming data, just as Venetian blinds are closed to block light. The learner resists being a part of the unwanted learning experience and resorts to some other cerebral activity, internal or external, to avoid the situation. In effect, the learner's self-concept has closed off the receptivity to the new information (p.20-21).

In order to develop an environment or climate where students can process information, it is important to build a solid learning environment. There are eight brain-compatible elements that form the foundation of learning, as defined in the Integrated Thematic Instruction Model (ITI), created by Kavolik and Olsen (1994). McGeehan (1999) further explains these eight elements:

Absence of Threat – access to the powers of the cerebral cortex for problem solving and product creation is possible only when there is no threat, real or perceived, present in the school environment.

Meaningful Content –when the information has person meaning (when it makes sense) – our brains can internalize and recall vast amounts of detailed information with remarkably little effort.

Choices – when learners can participate in an activity by choice, they are more successful because they bring the positive emotional state associated with doing something they want to do. They will be more interested, keeping the information in working memory, until it can be moved to long-term storage.

Adequate Time – learning something new takes time. When time is too short, the learner may resort to rote memory, become anxious and lose learning power, submit incomplete work or just give up. Each of these circumstances allows the information to drop out of the working memory, and eliminates the opportunity to move the information to long-term storage.

Enriched Environment – arranging the learning environment to one that is attractive and inviting, allows the learner to stick with new information long enough to be processed. Enriched environment also means providing the body and brain with access to experiences in the real world, varied resources to explore, and the opportunity to interact with real objects. McGeehan (1999) provides examples of an enriched environment:

> Frequent field trips, access to the Internet and to information stored on CD-ROM, many books on a variety of reading levels related to the topic, regular visits from community persons to share their expertise, and the chance to work often as a member of a cooperative group all reflect enriched environment .(p.11)

Collaboration – working together to accomplish something of importance to the individual or the group. The most important projects in business, education, religion, government, medicine, or just about anyplace else depends on collaboration.

Immediate Feedback – the sooner the learner knows how they are doing, the better the situation. Immediate feedback is important because the most difficult thing for the brain to do is to forget an old, well-learned mental program. If the learner knows how they are doing and the value of the progress they are making, it increases their motivation to continue toward the learning goal.

Mastery – in the context of Integrated Thematic Instruction (ITI), mastery means being able to apply what the learner understands in a real world situation.

The eight brain-compatible elements are important to remember as the teacher works to design an all-inclusive instructional model. Coupled with the use of the Rigor-Relevance Framework, by Daggett (1995), the teacher will be able to answer Sousa's questions, "Does it make sense?" and "Does it have meaning?" This framework also supports the purpose identified in the Carnegie (1996) report regarding real-world experiences and preparation for the world of work, and relates directly to "mastery" in the ITI model. Daggett (1995) has worked through the testing and assessment criteria, which should be an indication of what is being taught in American schools, and compared our methods of evaluation to those in Asia and Europe. As Americans try to raise the standards of education, they are falling behind in meeting the criteria for the workplace. Daggett's (1995) explains why this occurs:

> America today is a nation where jobs for unskilled labor are disappearing, placing all students without the ability to apply high-level math, science, and language arts skills at risk of not being able to obtain meaningful employment. Meanwhile, American schools are still locked onto the belief that the traditional indicators of educational success—paper-and pencil tests of knowledge—tell us all we need to know about student achievement. This thinking has resulted in more and more attention to testing over the last two decades in order to raise standards in schools. But instead, standardized testing has become the roadblock that keeps us from really moving forward to provide all students with rigorous and relevant skills, because it limits our focus to knowledge taught in a theoretical way. Standardized tests are still essential to measure basic knowledge. But while they are essential, they are no longer adequate. Students in today's technological, information-based society must not only have knowledge, but they must also learn how to apply that knowledge if they are to be successful as adults. (p.10)

In 1991, New York completed a statewide survey entitled "Career Preparation Validation Study." This involved a cross-section of several hundred businesses to determine the math and language arts skills that workers were using on the job. Daggett (1995) reports that the results showed that workers did a great deal of technical reading and writing on a daily basis in nearly all jobs. In addition, they experienced extensive speaking and listening responsibilities where they had to transmit work-related and technical information. In the areas of mathematics, workers used basic computation skills and, because of the prevalence of computer technology, statistics, logic, and probability, as well as measurement systems.

This information was then compared to the mathematics and language arts curriculum taught in schools. Daggett's (1995) findings concluded that an enormous disparity became readily apparent. "In school, language arts focused on reading and writing, with little emphasis on speaking and listening—the most widely used language arts skills in the workplace, and the reading and writing taught in schools was primarily for personal response to literature and magazine and newspaper articles" (Daggett, 1995, p.11).

In the workplace, people were reading and sometimes writing manuals, technical reports, safety codes, etc. In high school mathematics courses continued to offer separate curriculum in algebra, geometry, and trigonometry. Workers, however, seldom used any of those mathematical areas in isolation in the workplace. The gap between school and workplace was startling to school officials and policy makers throughout the state of New York. Since the same textbooks are used across the nation, similar findings would be true in other states as well.

Daggett (1995) has prepared a Rigor-Relevance Framework to assist teachers in measuring the amount of real-world application in their courses (See Appendix E). This model combines Bloom's Taxonomy with the Application Model as noted below.

Daggett (1995) explains:

Bloom's Taxonomy		Application Model	
1	Awareness	1	Knowledge of one discipline
2	Understanding/Comprehension	2	Apply knowledge in discipline
3	Application	3	Apply knowledge across disciplines
4	Analysis	4	Apply knowledge to real-world, predictable situations
5	Synthesis	5	Apply knowledge to real world, unpredictable situations
6	Evaluation		

(Daggett, 1995, p.14)

These taxonomies deal with two types of knowledge and skills: (1) knowledge for its own sake, [Bloom's Taxonomy] and (2) the ability to gather and use that knowledge to solve everyday problems [Application Model]. Within each type there are levels (See Appendix D). Levels A and C denote knowledge for its own sake. Examples of level A are: knowing that the world is round and that Shakespeare wrote Hamlet. Level C embraces higher levels of knowledge, which are taught in more advanced courses, such as knowing how the political system works and understanding the cultural diversity of our nation versus other nations.

The second type of knowledge and skills—gathering and using information—also has two levels. Level B would include knowing how to use math skills to make purchases and count change. The ability to access information in wide-area network systems and to gather knowledge from a variety of sources to solve a complex problem in the workplace is an example of level D knowledge.

This Rigor-Relevance Framework was then used to compare curriculum within the United States, Asia and Europe (See Appendix E for the results). In this study by Daggett (1995) some comparisons have been made with the United States, Asian and

European curriculums. The international study revealed a major difference between the United States and the other countries. The United States piles content upon content, giving students more and more theoretical knowledge as they climb to the upper levels of Bloom's Taxonomy in a subject area.

The other countries operate from the premise that students must be able to apply what they are learning, so they use contexts other than school subjects, notably work, to teach academics. "In their efforts to establish the highest standards in the world, they [other countries] are moving toward having all students take rigorous, applied courses in math, science, and language arts, with a major emphasis on work-related applications" (Daggett, 1995, p.15).

The American business community has been saying for over a decade that this country is struggling to maintain its competitive position in the global marketplace— in part because our high school graduates lack the skills and knowledge needed to function in the high-tech and rapidly changing work world. Daggett's (1995) study provides persuasive evidence that American schools must focus much more attention on applied courses in mathematics, science, and language arts for all students as well as make a stronger commitment to school-to-work initiatives. While the curriculum taught in the United States is essential, it is not adequate to prepare high school students for the next phase of their life. This curriculum does not support the Carnegie (1995) report purposes, specifically: "High school must function as a transitional experience, getting each student ready for the next stage of life, whatever it may be for that individual, with the understanding that, ultimately, each person needs to earn a living" (Carnegie, 1995, p.2).

Daggett (1995) also compared the public expectation of what should be taught in high school with what is actually taught in the high schools in Michigan (See Appendix F for the results). The results of this comparison are similar throughout the country. As shown in Appendix F, the current curriculum was mainly in the A and C sections on the scattergram, while the public's expectations called for knowledge of types B and D. Daggett (1995) explains:

> These data do not mean that schools should abandon A and C—which constitute rigorous, theoretical curriculum—for the purposes of adding B and D, which is a relevant curriculum. Instead, all students need a curriculum with a strong theoretical base as well as experiences which help them understand how that knowledge can and will be applied in a variety of settings in their lives; that is, all students need A, B, C, and D. (p.52)

The comparison of data gathered through citizen participation indicates that substantial curriculum and assessment changes are needed in our schools. These changes must be accompanied by major staff development efforts. Teachers cannot teach or assess content that they have not had the opportunity to master.

As teachers look at ways to gain mastery of content, <u>The teaching gap</u> by Stigler and Hiebert proposes a well-researched plan for mastery through a staff development and lesson study model. Building on the information found in the Third International Mathematics and Science Study (TIMSS), authors Stigler and Hiebert (1999) identify a method to improve instruction. "School learning will not improve markedly unless we give teachers the opportunity and support they need to advance their craft by increasing the effectiveness of the methods they use" (Stigler and Hiebert, 1999, p.ix).

This study compared eighth-grade mathematics classes in Germany, Japan and the United States. The findings identify some issues that have not been part of other's suggestions for improvement. Stigler and Hiebert (1999) state:

> We are not talking about a gap in teachers' competence but a gap in teaching methods...It refers to the difference between the kinds of teaching needed to achieve the educational dreams of the American people and the kind of teaching found in most American schools...The most alarming aspect of classroom teaching in the United States is not how we are teaching now but that we have no mechanism for getting better. (p.x-xi)

This study used video as well as focus groups; curriculum guides and assessment tools to evaluate the teaching quality and teaching methods used in the eighth-grade mathematics classes in the U.S., Germany and Japan. This study reached different conclusions than what has been identified in the media. Stigler and Hiebert (1999) identify the differences:

> Americans focus on the competence of teachers. They decry the quality of applicants for teaching positions and criticize the talent of the current teaching corps. But we come away with a different conclusion: Although the viability in competence is certainly visible in the videos we collected, such differences are dwarfed by the difference in teaching methods that we see across cultures...Students' day-to-day experiences are mainly determined by the methods most commonly used by teachers within a culture...To put it simply, we were amazed at how much teaching varied across cultures and how little it varied within cultures. (p.10-11)

The TIMSS study further identifies the differences in teaching culture. Stigler and Hiebert (1999) continue:

> What we can see clearly is that American mathematics teaching is extremely limited, focused for the most part on a very narrow band of procedural skills. Whether students are in rows working individually or sitting in groups, whether they have access to the latest technology or are working only with paper and pencil, they spend most of their time acquiring isolated skills through repeated practice. Japanese teaching is distinguished not so much by the competence of the teachers as by the images it provides of what it can look like to teach mathematics in a deeper way, teaching for conceptual understanding. Japanese classrooms spend as much time solving challenging problems and discussing mathematical concepts as they do practicing skills. (p.11-12)

Stigler and Hiebert (1999) offer a further explanation:

> Teaching is a cultural activity. We learn how to teach indirectly, through years of participation in classroom life, and we are largely unaware of some of the most widespread attributes of teaching in our own culture...The fact that teaching is a cultural activity explains why teaching has been so resistant to change. But recognizing the cultural nature of teaching gives us new insights into what we need to do if we wish to improve it. (p.11-12)

So, how do we go about changing the culture of teaching? Are the current reforms headed in the right direction? Are teachers meeting the challenges of raising standards? Stigler and Hiebert (1999) identified the problem of how to improve teaching on a wide scale as one that has been seriously underestimated by policymakers, reformers, and the public in this country. The American approach has been to write and distribute reform documents and ask teachers to implement the recommendations contained in such documents. Those who have worked on this problem understand that this approach simply does not work. The teaching profession does not have enough knowledge about what constitutes effective teaching and teachers do not have the means of successfully sharing such knowledge with one another. Stigler and Hiebert (1999) suggest:

> To really improve teaching we must invest far more than we do now in generating and sharing knowledge about teaching. This is another sort of teaching gap. Compared with other countries, the United States clearly lacks a system for developing professional knowledge and for giving teachers the opportunity to learn about teaching. (p.12)

American teachers, compared with those in Japan, for example, have no means of contributing to the gradual improvement of teaching methods or of improving their own skills. American teachers have no program for collaboration of teaching and learning experiences. American teachers are left alone; an action sometimes justified on grounds of freedom, independence, and professionalism.

To identify change in teaching, it is important to look at the teaching culture and evaluate what needs to be changed. Stigler and Hiebert (1999) suggest that teaching is a cultural activity, teachers should begin the improvement process by becoming more aware of the cultural scripts teachers are using. This requires comparing scripts, seeing that other scripts are possible, and noticing things about their own scripts that they had never seen before.

Becoming aware of the scripts teachers use helps them see that they come from choices they make. The choices might be understandable, but still they are choices, and once we are aware of them, other choices can be made. Stigler and Hiebert (1999) conclude:

> Improving cultural scripts for teaching is a dramatically different approach from improving skills of individual teachers, but it is the approach called for if teaching is a cultural activity. No matter how good teachers are, they will only be as effective as the scripts they are using. To improve teaching over the long run, we must improve the script. (p. 101)

Looking at the improvement in this way creates new dilemmas. How do we change the scripts in a culture that basically uses the same one? What models do we use to rewrite those scripts? Stigler and Hiebert (1999) suggest that change must occur through a process that leads to gradual, incremental improvements in teaching over time. This process should include clear learning goals for students, a shared curriculum, the support of administrators, and the hard work of teachers striving to make gradual improvements to their practice.

The suggestion for this improvement, which would be gradual, rather than immediate, would be the Stigler and Hiebert (1999) lesson study model. This model would be fashioned after the Japanese kounaikenshuu, a continuous process of school-based professional development. Stigler and Hiebert (1999) explain:

> In the United States, teachers are assumed to be competent once they have completed their teacher-training programs. Japan makes no such assumption. Participation in school-based professional development groups is considered part of the teacher's job in Japan. These groups play a dual role: not only do they provide a context in which teachers are mentored and trained, they also provide a laboratory for the development and testing of new teaching techniques. (p.110)

Lesson study involves a group of teachers, divided by grade level, that meet on a regular basis to build one lesson. This lesson is research-based and has been identified by the group for improving instruction. The lesson study process is: 1) defining the problem, 2) planning the lesson, 3) teaching the lesson, 4) evaluating the lesson and reflecting on its effect, 5) revising the lesson, 6) teaching the revised lesson, 7) evaluating and reflecting, again, and 8) sharing the results. This lesson-study model is effective because it is based on a long-term continuous improvement model; it maintains a constant focus on student learning; it focuses on the direct improvement of teaching in context; it is collaborative and teachers who participate in lesson study see themselves as contributing to the development of knowledge about teaching as well as to their own professional development.

As the discussion evolves around the culture of teaching, there are interesting analogies in the ITI model created by Kavolik and Olsen (1994). In the book, Synergy: Transforming America's high schools through integrated thematic instruction by Olsen (1995), the discussion of memes takes place. Olsen (1995) explains, when discussing the "memes" as described by Richard Dawkins:

> Dawkins, while emphasizing the importance of genes to cells, argues that memes exercise the same kind of control in the mind. It is memes, not genes that have been shaping the force of our culture. (1-6)

Building on Dawkins' discussion of memes, Bergland (1985), in his book Fabric of mind makes the following comments:

> The genetic distinction of Beethoven or Einstein is lost in three or four generations; their splendid genes, once poured into the extraordinarily large vat of the human generic pool, are lost forever. But the memes of Beethoven and

Einstein, their good ideas, are passed from one generation to another and have an eternal significance. All animals are gene dependent. But the evolution of our culture, of our civilization, is meme dependent. (p.26-27)

The identification of memes speaks directly to the culture of teaching. Olsen (1995) also suggests modification in the teaching culture, addressing the differences as new memes. Olsen (1995) proposes these new memes should be consistent with brain-research and the intellectual, physical, psychological, social, moral and ethical development needs of the high school student. Olsen's (1995) new memes are:

- The purpose of public education is the perpetuation of democracy
- The curriculum for the 21st century must be based on reality; not on "disciplines" and textbooks
- Life is the best curriculum for adolescents
- Learning is a personal affair
- Instructional strategies should provide students choices which allow for their unique ways of learning
- Curriculum should be framed so as to reduce "telling about" and instead should be based upon exploration, discovery, and application of concepts to the real world
- Assessment should be reality-based(p.1-18)

In an effort to utilize the most recent brain-compatible research, it is important to remember the premise that "curriculum should be based on being there experiences because conceptual development is based on sensory input: Being there experience produces concepts that produce language that creates the application to the real world.

Talking about content or skills works only with those students who have had prior experience with what is being discussed"(Olsen, 1995,p.2-13). Olsen (1995) continues:

> Powerful, brain-compatible learning for student occurs when high levels of sensory input from being there experiences are processed by the pattern-seeking brain to identify and construct meaning (The concept, thing, or event is understood.). Language (the attachment of a word to this new understanding) then makes possible further exploration and application (program-building for long-term retention and use). The brain readily learns (makes meaning) and applies (builds a program for using) information learned in this sequence. (p.2-13) (See Appendix G for sensory input suggestions)

The terms pattern-seeking and program-building need additional explanation. Pattern-seeking occurs when the brain learns by sifting through massive amounts of input arriving simultaneously from all the senses, processing thousands of bits of information per minute. As the brain attempts to make sense out of the chaos which surround each of us, it constantly searches for pattern that can impose meaning on the input it receives. Hart (1983), in his book, Human brain and human learning, identifies six major categories for pattern-seeking (See Appendix H).

Program-building is defined as programs that are the fixed sequence for accomplishing some intended objective. In other words, to carry on activities, one must constantly select a program from among those stored in the brain and put it to use.

The ITI learning methods are described below. Being there experiences are the most active learning methods followed by immersion, hands on of the real thing, hands on of representational items, secondhand and last, symbolic.

Being there input occurs when real things are studied in their real world context, when all 19 senses are activated. This allows the learner to sift through input until a pattern is recognized and understood and a mental program for using it is developed.

Immersion input replicates the real world context of the being there experience in the classroom as fully as possible, turning the classroom into a real-life example. The environment provides input for 13 of the 19 senses.

Hands on of the real thing provides input through examination of real world things but without the context of being there or immersion, engaging 9 of the 19 senses.

Hands on of representational items provide input from models of real things. Without the context of being there or immersion, it elicits response from only 4 of the 19 senses. Such limited sensory input provides limited brain activity and thus limits pattern-seeking capabilities for many learners. Program-building opportunities are all but non-existent because real world applications are so difficult to create with only representational items.

Secondhand input can be found in books, computers, videotapes, and other multi-media presentations, which can activate only sight, hearing and eidetic imagery. Such limited input makes pattern-seeking difficult and provides no opportunities for program-building.

Symbolic is the most difficult input to process. Fewer than 20 percent of students can learn well through this type of input. High linguistic and spatial intelligence is needed to make use of symbolic input, plus prior being there experiences related to the new learnings (See Appendix I).

The learners of today are coming to school with less being there experiences, consequently the significance of sensory input is even more important for them. In the past, teachers could assume that students came to school with a wide range of experience of the real world and the concepts and language that come with such experience. They had the experiences from a farming background—animal husbandry, crops of all kinds, the economics of supply and demand, problem-solving spurred by equipment that breaks down in a remote field, and the geometry and mathematics involved in building fences and new buildings. Children also had the experiences of a functional neighborhood—as a part of the street markets with a wide range of firsthand experiences as well. Consequently, schools of the past could use a wide range of secondhand sources during instruction—books, textbooks, workbooks, worksheets, dittos, picture, models, blocks, dioramas, and, more recently, videos, film loops, etc.—because children came to school possessing a rich tapestry of being there experiences to build upon.

Today's students, on the other hand, come with a shortage of experiences with the real world and the concepts and language that accompany them. This student is not prepared to learn from those secondhand sources. Eighty percent of reading comprehension depends upon prior knowledge. Teachers need to find ways to give them those real world experiences in the classroom. Specifically, students can only take from a book what they bring to the book. Books can expand their knowledge but cannot create it from scratch.

Sensory input can occur in many ways. Appendix H identifies the different sensory possibilities. The learning modes of students are directly related to a student's preference to the sensory input. Eight intelligences have been identified through significant research over the last twenty years. These intelligences are descriptions of how individuals use their intelligences and the sensory input to solve problems and fashion products. Students prefer learning in the mode that they feel comfortable with.

but they can learn in a variety of modes. Below is Armstrong's (2000) description of the eight intelligences and ways to design lessons to provide the sensory input that allows information to pass through Sousa's perceptual register, move through intermediate and working memory and on to long-term storage.

Eight Ways of Learning			
Children who are highly:	Think	Love	Need
Linguistic	in words	reading, writing, telling stories, playing word games	books, tapes, writing tools, paper, diaries, dialogue, discussion, debate, stories
Logical-Mathematical	by reasoning	experimenting, questioning, figuring out logical puzzles, calculating	materials to experiment with, science materials, manipulatives, trips to the planetarium and science museum
Spatial	in images and pictures	designing, drawing, visualizing, doodling	art, LEGOS, video, movies, slides, imagination games, mazes, puzzles, illustrated books, trips to art museums
Bodily-Kinesthetic	through somatic sensations	dancing, running, jumping, building, touching, gesturing	role play, drama, movement, things to build, sports and physical games, tactile experiences, hands-on learning
Musical	via rhythms and melodies	singing, whistling, humming, tapping feet and hands, listening	sing-along time, trips to concerts, music playing at home and school, musical instruments
Interpersonal	By bouncing ideas off other people	leading, organizing, relating, manipulating, mediating, partying	friends, group games, social gatherings, community events, clubs, mentors/apprenticeships
Intrapersonal	in relation to their needs, feelings, and goals	setting goals, mediating, dreaming, planning, reflecting	secret places, time alone, self-paced projects, choices
Naturalistic	through nature and natural forms	playing with pets, gardening, investigating nature, raising animals, caring for planet earth	access to nature, opportunities for interacting with animals, tools for investigating nature (e.g., magnifying glass, binoculars)

(p.22)

These descriptions can assist teachers in identifying the students' learning modes, assist in planning lessons and activities, and assessing student learning.

Although learners have preferences of learning modes, they do not possess only one preference; they possess a combination of many. Armstrong (2000) explains:

> A key point in the MI theory is that most people can develop all their intelligences to a relatively competent level of mastery. Whether intelligences develop depends on three main factors:
>
> - Biological endowment, including hereditary or genetic factors and insults or injuries to the brain before, during and after birth;
> - Personal life history, including experiences with parents, teachers, peers, friends and others who either awaken intelligences or keep them from developing;
> - Cultural and historical background, including the time and place in which you were born and raised and the nature and state of cultural or historical developments in different domains.(p.17)

To fully use the MI and ITI initiatives, the teacher must work with other teachers to create consistency and collegiality. Hoerr (2000) states:

> As powerful as the theory of multiple intelligences can be in changing how educators view students, a school is not likely to succeed at using MI productively without a high degree of collegiality. I can conceive of good schools in which the educators do not subscribe to MI theory; I cannot imagine a school in which the staff does not work together as colleagues. In a MI school, collegiality is especially important because educators create curriculum, design instructional strategies, and invent assessment tools. Teachers and administrators work as

colleagues to fashion strategies that reflect their assumptions and respect the unique contexts in which they work. (p.17)

Conclusions and Recommendations

High schools are the last frontier of change in the K-12 educational setting. Teachers in those high schools have been following the scripts of teachers past, and much of the curriculum in high schools are the same as 100 years ago, because teaching is a cultural activity. As teachers have worked on making sense within a lesson as they develop instructional materials, they have been short on making meaning of the materials—telling students the relevance of the materials. With the brain research, teachers now know why they need to change—the students of today do not have the real-world experiences to draw from, and more varied sensory experiences are necessary in order for students to store the information in the long-term storage of their brain. There is no method or process for teaching improvement in the United States, and in order for systemic change to occur, this must be part of the plan for change.

The Dick and Carey (1996) Instructional Design Process is the appropriate framework to use to initiate the long-term, systemic changes needed in the high schools of the 21st century (See Appendix J). "A more contemporary view of instruction is that it is a systematic process in which every component (i.e., teacher, students, materials, and learning environment) is crucial to successful learning"(Dick and Carey,1996,p.2). The nine initial purposes presented in the Carnegie (1995) report would help in framing the philosophy behind the need to change high schools that meet student needs of this new century.

The difficulty comes in assimilating the information contained in the Instructional Design Process and all the other information presented into one, workable model for high school design. The lesson study model by Stigler and Hiebert (1999) would be the process used for implementing change. Sousa (1995) has refined Hunter's (1982) lesson design model, which would be the beginning structure of a meaningful lesson (see Appendix L), and Daggett's (1995) Rigor-Relevance Framework is a check and balance for rigor and relevance (sense and meaning). The Dick and Carey (1996) Instructional Design Process is the mechanics of implementing the change. These components need to take into consideration that a gradual change in instructional strategies is preferred. The Dick and Carey (1996) Instructional Design Process has been used as the basic structure for the other research-based instructional design components (See Appendix K for a visual representation of the new model). The components of the other models have been identified as they flow into the Instructional Design Process steps.

The following chart is used to explain the inclusive model:

<table>
<tr><th colspan="5">Instructional Model for High Schools of the 21st Century</th></tr>
<tr><th></th><th>Instructional Design Model
Dick and Carey (1996)</th><th colspan="3">Other Models for Incorporation</th></tr>
<tr><td></td><td>Assess Needs to Identify Goals</td><td rowspan="9">Use Lesson Study Model
Stigler and Hiebert (1999)</td><td>Look at overall building goals as well as curriculum goals

Look at curriculum needs regarding Rigor-Relevance Framework and Instructional Methods and Learning Modes</td><td>Carnegie (1995)
Olsen (1995)

Daggett (1995)

Olsen (1995)
Sousa (1995)</td></tr>
<tr><td></td><td>Conduct Instructional Analysis</td><td>Use Rigor-Relevance Framework for analyzing real-world experiences

Develop opportunities to cover depth of subject, not breadth of materials</td><td>Daggett (1995)

Stigler and Hiebert (1999)</td></tr>
<tr><td></td><td>Analyze Learners and Contexts</td><td>Identify learner's preferred learning mode
Look at how we organize time during school day and class period</td><td>Olsen (1995)

Carnegie (1995)
Sousa (1995)</td></tr>
<tr><td rowspan="5">Revise Instruction</td><td>Write Performance Objectives</td><td>Align objectives with building philosophy statement and school climate guidelines

Keep building and district goals in mind</td><td>Carnegie (1995)

Olsen (1995)

Stigler and Hiebert (1999)</td></tr>
<tr><td>Develop Assessment Instruments</td><td>Use standardized tests for theory –
Develop/identify other assessments for real-world application.

Use technology for assessment whenever possible</td><td>Daggett (1995)
Daggett (1995)
Olsen (1995)

Carnegie (1995)</td></tr>
<tr><td>Develop Instructional Strategy</td><td>Use Sousa's model for lesson design as basic lesson structure—including questions to ask while planning lessons.

Think in terms of the brain's primacy-regency effect and time to use working and immediate memory.</td><td>Sousa (1995)

Sousa (1995)</td></tr>
<tr><td>Develop and Select Instructional Materials</td><td>Find ways to develop <u>being there</u> experiences. Eliminate the use of secondhand materials as a regular mode of instruction

Integrate the use of technology whenever possible</td><td>Olsen (1995)

Carnegie (1995)</td></tr>
<tr><td>Design and Conduct Formative Evaluation of Instruction</td><td>Use a variety of assessment methods for evaluation.</td><td>Daggett (1995)
Olsen (1995)
Sousa (1995)</td></tr>
<tr><td></td><td>Design and Conduct Summative Evaluations</td><td>Continue to use the research for design of summative evaluation</td><td>All resources</td></tr>
</table>

"Perhaps the most critical event in the instructional design process is identifying the instructional goal" (Dick and Carey, 1996,p.15). Further discussion of the importance of curriculum revision is echoed by Costa and Kallick (2000):

> When we begin to address the very heart of the organization, the curriculum, then all other reform efforts will fall into place. We have been building reform structures around old-fashioned curriculum…Redesign the curriculum as the main component of restructuring the school. (p.16)

The Stigler and Hiebert's (1999) lesson study model comes from the identification of six principles that embody the rationale for improvement of teaching. These principles are: 1) Expect improvement to be continual, gradual and incremental – because teaching is a system that is deeply embedded in the surround culture of schools, any changes will come in small steps, not in dramatic leaps. This means that we must take a long-term view when we design initiatives for improving teaching. Teachers must be allowed and encouraged to invent small changes in the system of teaching and then to keep track of these changes so they can be accumulated and shared.

2) Maintain a constant focus on student learning goals – the goal of improving teaching is improving students' learning. Improving complex system, such as teaching, requires a relentless focus on the bottom-line goals—in this case, students' learning—and a commitment to evaluate changes with respect to these goals.

3) Focus on teaching, not teachers – long-term improvement in teaching will depend more on the development of effective methods of teaching than on the identification and recruitment of talented individuals into the profession.

4) Make improvements in context – because teaching is complex, improvements in teaching will be most successful if they are developed in the classrooms where teachers teach and students learn.

5) Make improvement the work of teachers – one way to ensure that improvements can be developed in context is to entrust change to those engaged in the activity—classroom teachers. They are best positioned to understand the problems that students face and to generate possible solutions.

6) Build a system that can learn from its own experience – if efforts to improve schools are going to add up to more than just a temporary fix, it is necessary to find a way to accumulate knowledge about teaching and to share this knowledge with new practitioners entering the teaching profession.

Stigler and Hiebert (1999) have outlined the following lesson study model:

1	Lesson study would require 2 hours per week of uninterrupted study.
2	The lesson study groups could be formed on the basis of shared interests, shared problems, common curriculum expectations or other criteria that make sense for planning common lessons.
3	The group would work in the study group to identify an explicit goal that is consistent with the mission of the school.
4	The lesson study group would set goals that articulate the teacher's judgements of the problems that impede students' learning—begin by addressing those topics and issues that are most in need of improvement.
5	The lesson study group would select a particular lesson in which the particular problem could be addressed.
6	The group would identify what the learning goal for the lesson is and how they will know that they have achieved it. The goal and measurement should relate to district and state standards and assessment systems.
7	The group would develop a work plan for the year and then follow that plan. The plan would consist of: (a) an allocation of initial time for finding out more about how students learn the concept in question (b) determining what others recommend for teaching these concepts effectively (c) learning more about concepts themselves (d) time for designing improved lessons (e) trying the lessons out with students

	(f) revising the lessons accordingly (g) repeating the cycle (h) time to write a report of their work to share with colleagues

As lessons are designed by the lesson study group, Sousa (1995) has created two tools for to use (See Appendix M and N). Appendix M identifies the brain research that supports the lesson design model of Madeline Hunter (1982). Appendix N consists of questions to answer throughout the design process to assure that brain-compatible components are a part of each lesson. Both appendices can be used to assist the lesson study group in creating the new script that can improve teaching and learning.

The suggestions for systemic change that have been presented are significant, and the will of teachers to participate is key to systemic change. Members of the high school staff need to make concerted efforts to follow the research to eliminate the gap in what high schools are and what high schools should be. Change does not and should not happen over night. There needs to be a partnership of all stakeholders to assure that high schools meet the needs of the 21st century.

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Appendix A

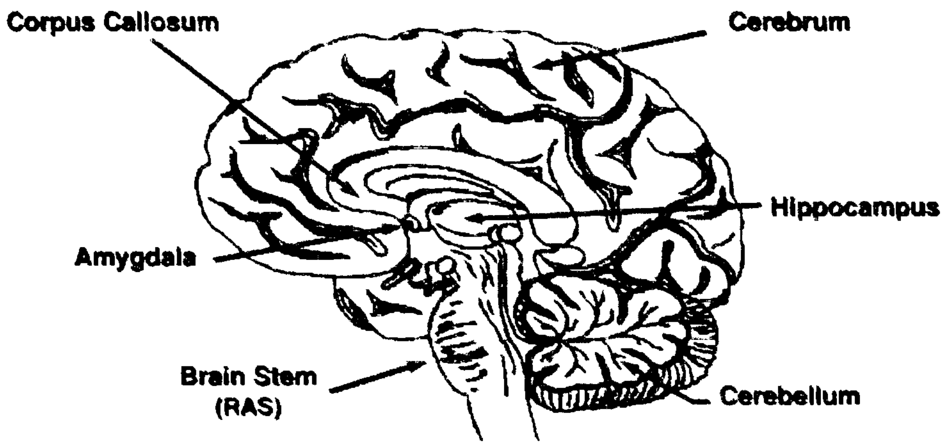


Figure 1.1. Cross section of the human brain.

Taken from How the Brain Learns by Dr. David Sousa, p. 2

Appendix B

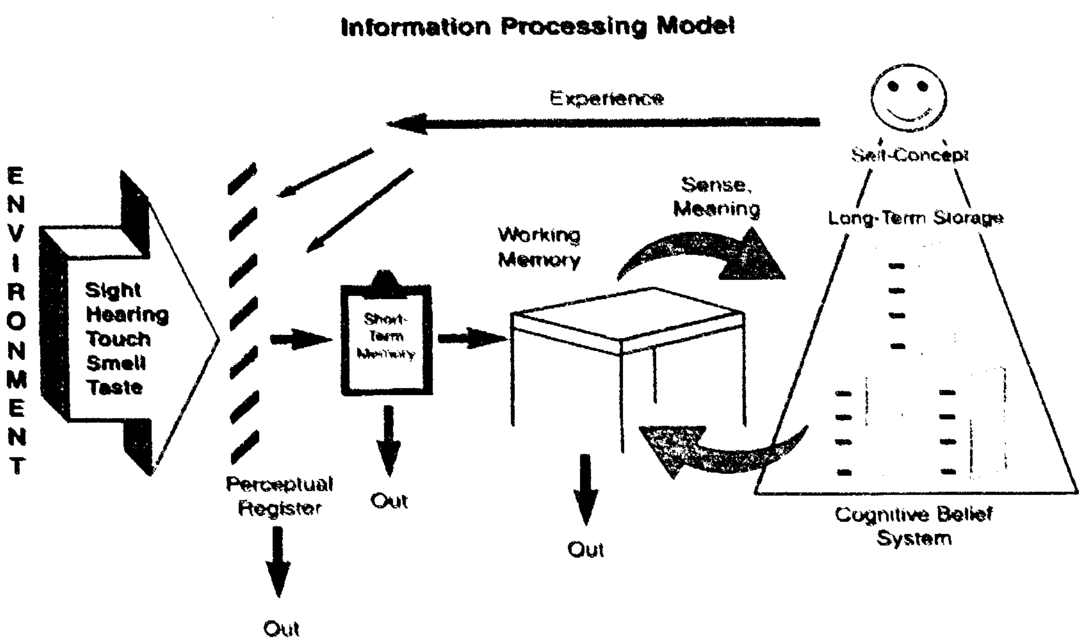


Figure 2.1. The Information Processing Model shows how the brain deals with information from the environment. (Adaptation and enhancement of original model by Robert Stahl.)

Taken from How the Brain Learns, Dr. David Sousa, p. 11

Appendix C

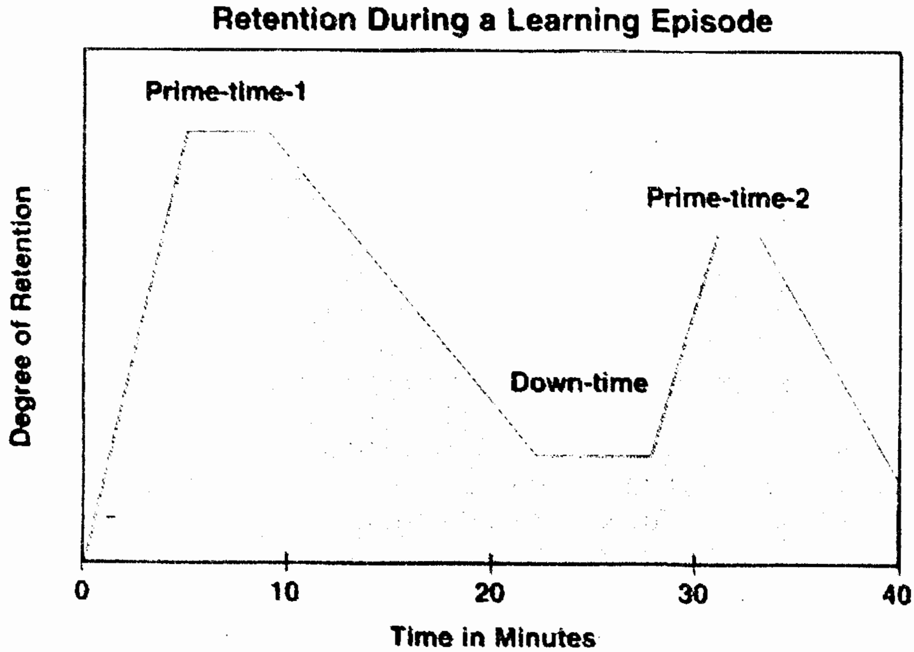
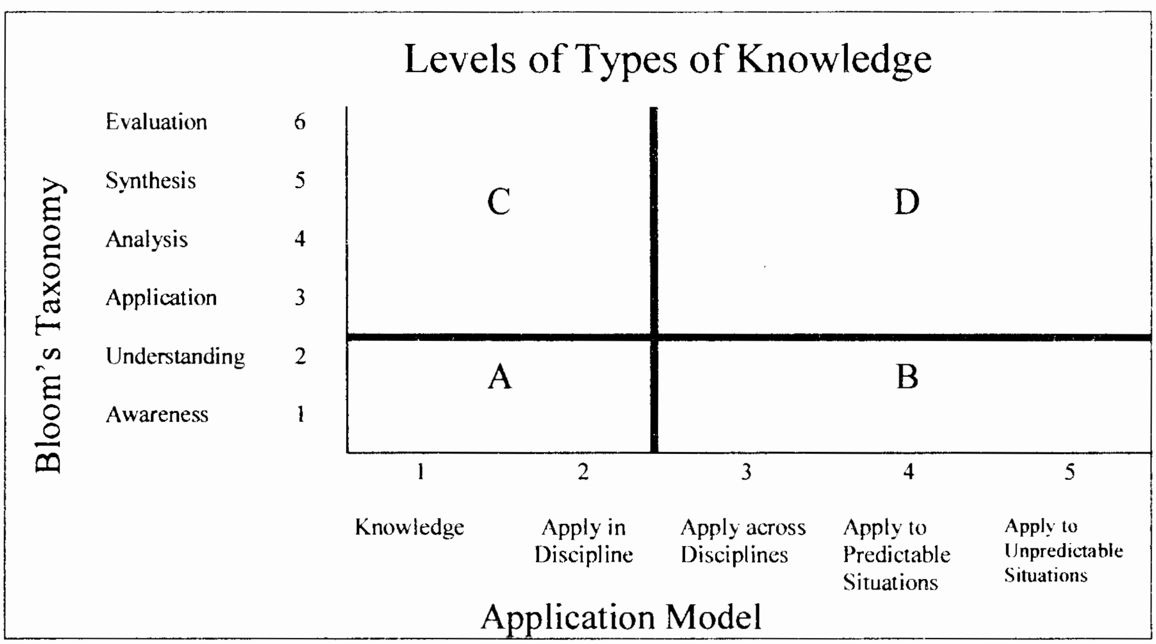


Figure 3.2. The degree of retention varies during a learning episode.

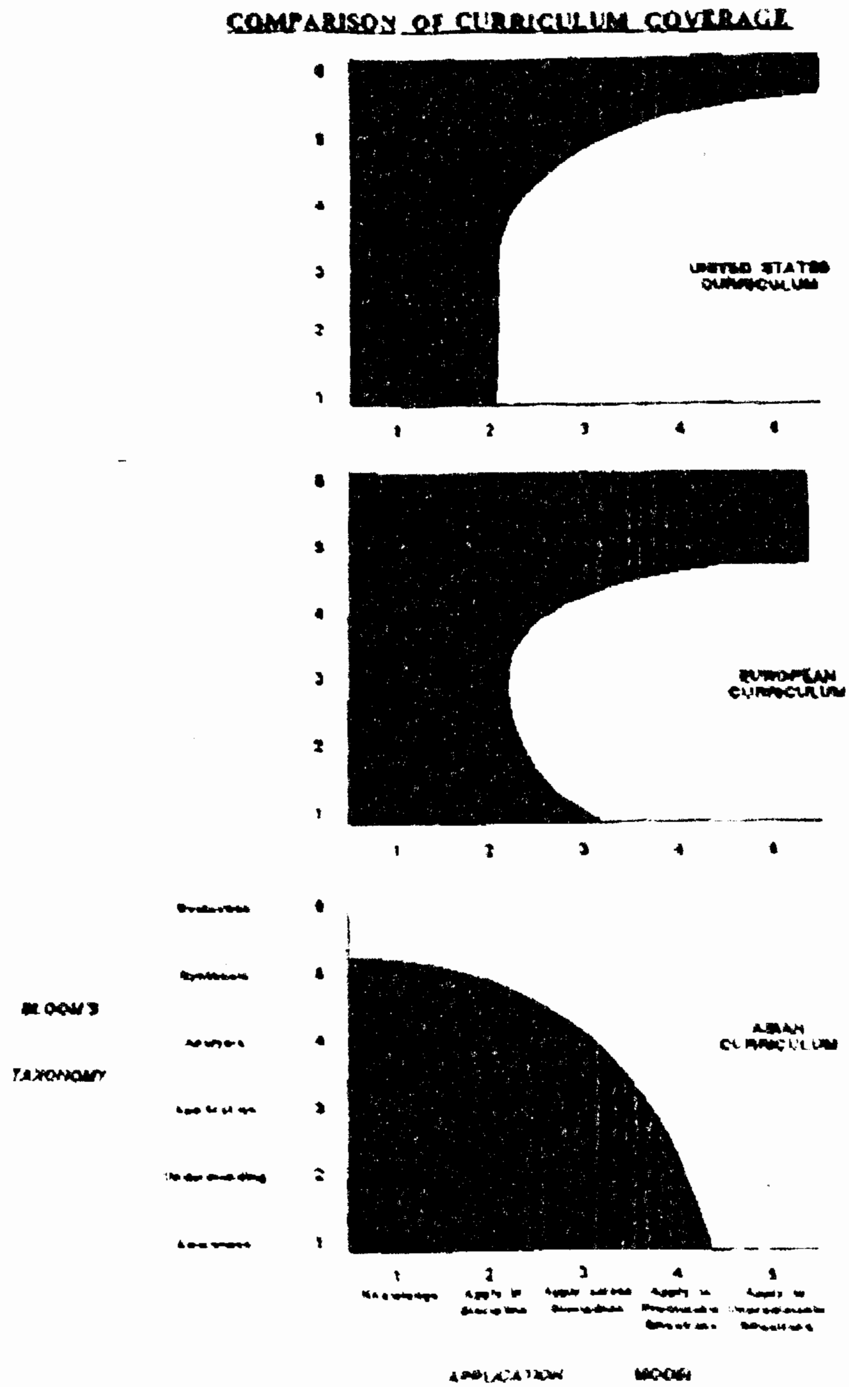
Taken from <u>How the Brain Learns</u> by David A. Sousa, p. 38

Appendix D



Taken from <u>Testing and Assessment in American Schools––Committing to Rigor and Relevance</u> by Dr. Willard Daggett, p. 16

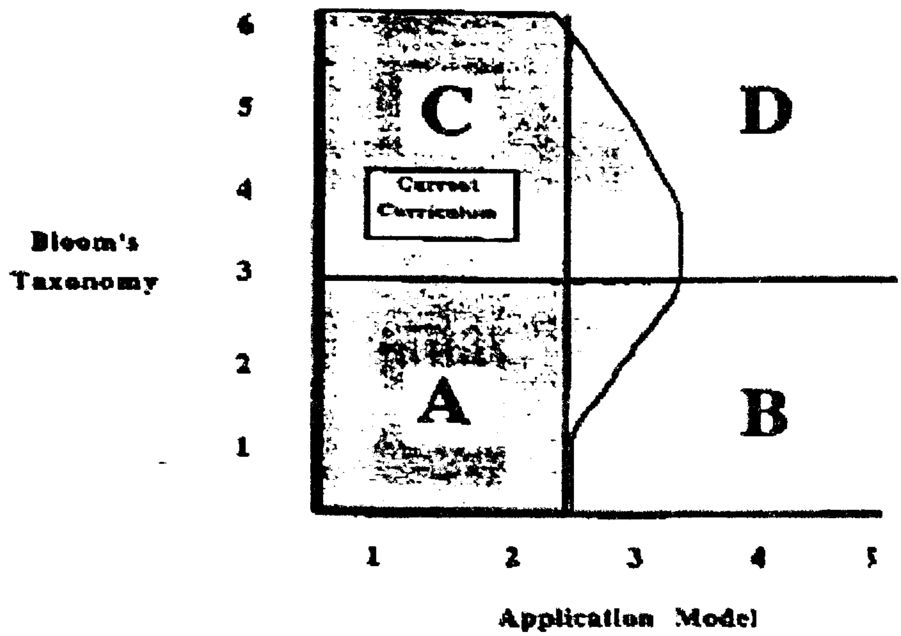
Appendix E

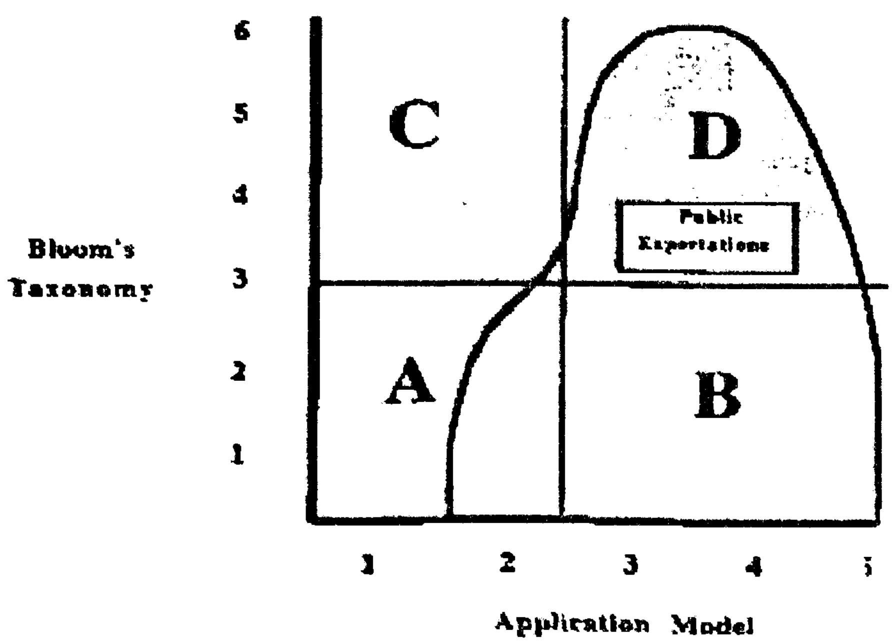


Taken from Testing and Assessment in American Schools—Committing to Rigor and Relevance by Dr. Willard Daggett p. 14

Appendix F

Michigan Curriculum vs. Public Expectations





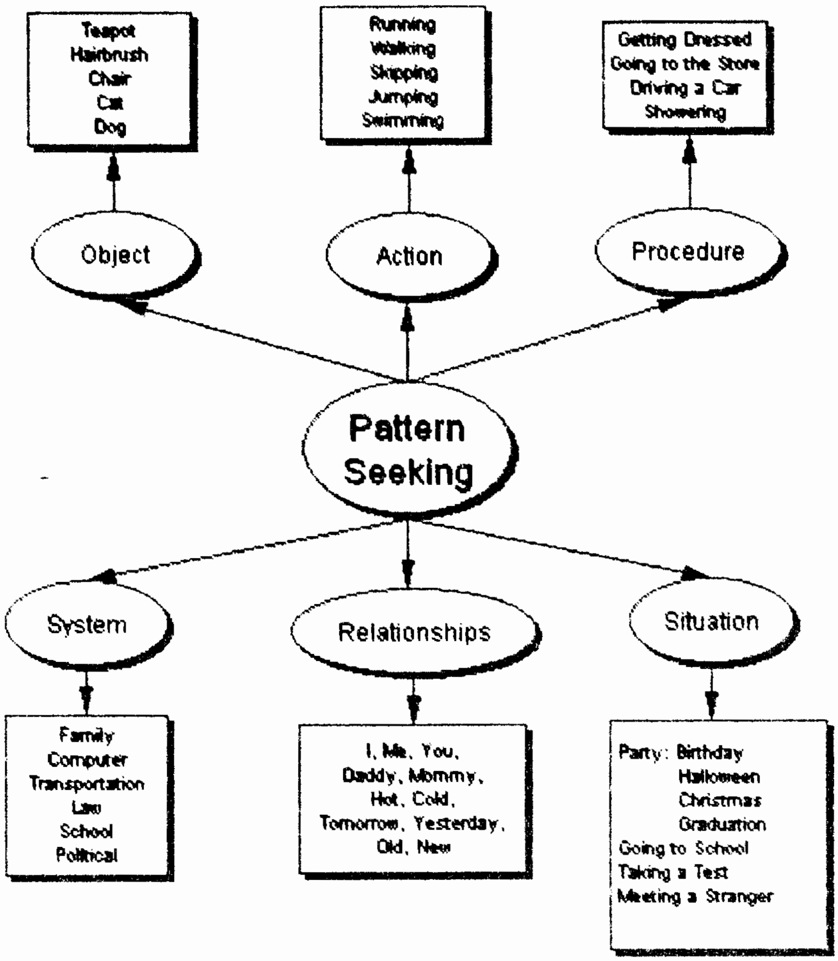
Taken from Testing and Assessment in American Schools—Committing to Rigor and Relevance by Dr. Willard Daggett, p. 53

Appendix G

The 19 Senses	
Senses	Kinds of Input
Sight	Visible Light
Hearing	Vibrations in the air
Touch	Tactile contact
Taste	Chemical molecular
Smell	Olfactory molecular
Balance	Kinesthetic geotropic
Vestibular	Repetitious movement
Temperature	Molecular motion
Pain	Nociception
Eidetic imagery	Neuroelectrical image retention
Magnetic	Ferromagnetic orientation
Infared	Long electromagnetic waves
Ultraviolet	Short electromagnetic waves
Ionic	Airborne ionic charge
Vomeronasal	Pheromonic sensing
Proximal	Physical closeness
Electrical	Surface charge
Barometric	Atmospheric pressure
Geogravimetric	Sensing mass difference

Taken from Synergy: Transforming America's High Schools through Integrated Thematic Instruction by Karen D. Olsen, p. 2-10

Appendix H



Synergy: Transforming America's High Schools Through Integrated Thematic Instruction
by Karen D. Olsen, p.2-28

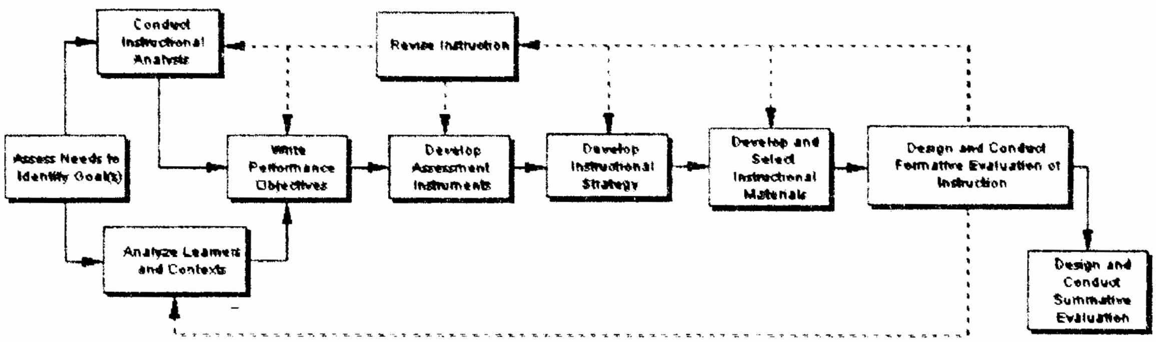
Appendix I

Intelligence as a function of Experience					
					Unforgettable Learning
					Barometric
					Geogravimetric
					Ionic
					Untraviolet
					Infared
	-				Magnetic
				Electrical	Electrical
				Proximal	Proximal
				Vestibular	Vestibular
				Balance	Balance
			Vomeronasal	Vomeronasal	Vomeronasal
			Pain	Pain	Pain
			Temperature	Temperature	Temperature
			Smell	Smell	Smell
			Taste	Taste	Taste
		Touch	Touch	Touch	Touch
	Eidetic Imagery	Eidetic Imagery	Eidetic Imagery	Eidetic Imagery	Eidetic Imagery
Hearing	Hearing	Hearing	Hearing	Hearing	Hearing
Sight	Sight	Sight	Sight	Sight	Sight
Symbolic	Second Hand	Hands on Representation	Hands on Real Things	Immersion	Being There

Taken from Synergy: Transforming America's High Schools through Integrated Thematic Instruction by Karen D. Olsen, p. 2-14—2-15

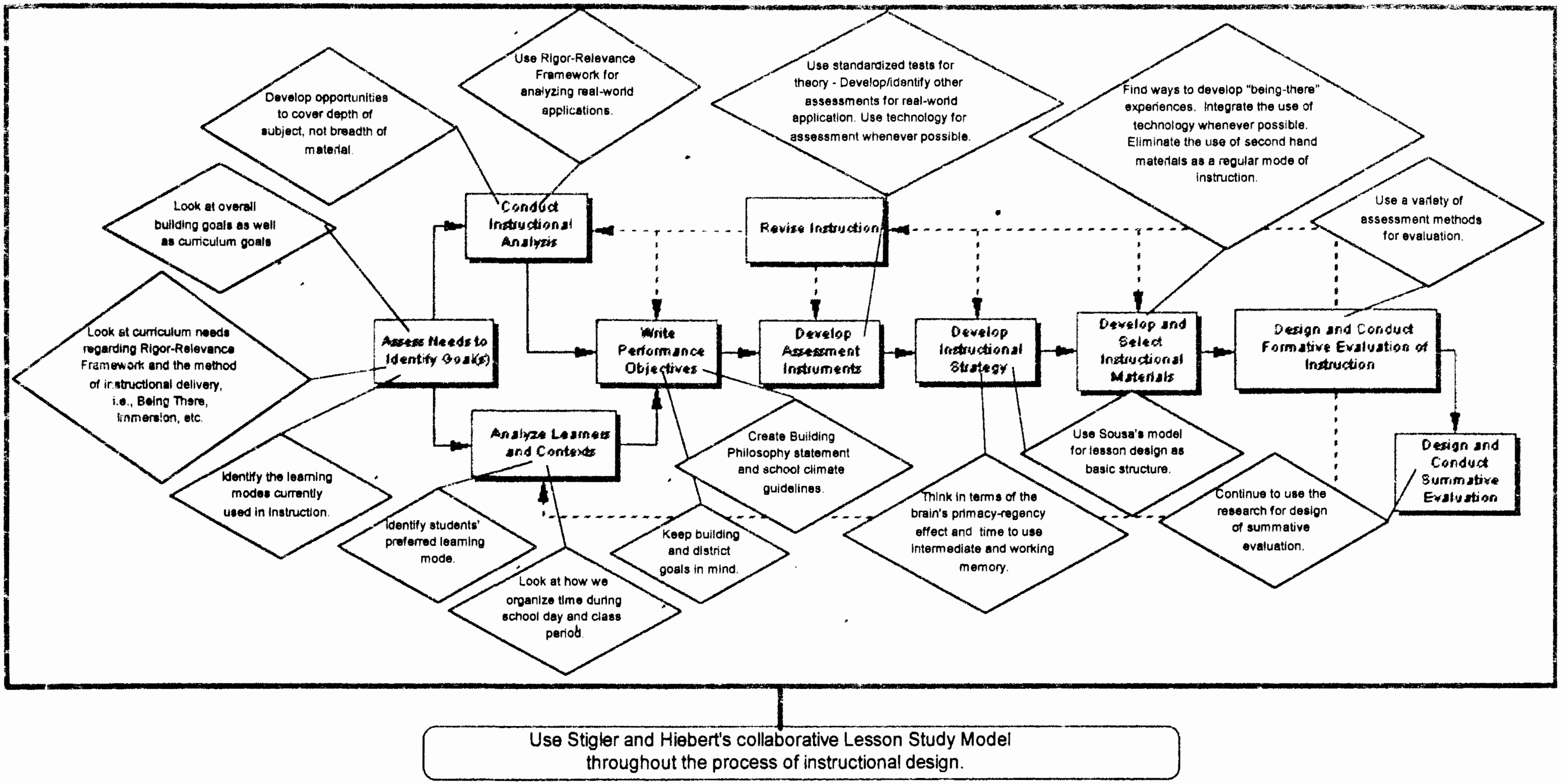
Appendix J

Instructional Design Process



Taken from The Systematic Design of Instruction by Walter Dick and Lou Carey, p.15

Instructional Model for the High School of the 21st Century



Appendix K

Appendix L

Hunter and Sousa Lesson Design		
1	Anticipatory Set	This strategy captures the student's focus. The set is most effective when it: (a) allows students to remember an experience that will help them acquire the new learning (positive transfer) (b) involves active student participation (c) is relevant to the learning objective
2	Learning Objective	This is a clear statement of what the students are expected to accomplish during the learning episode, including the levels of difficulty and complexity, and should include (a) a specific statement of the learning (b) the overt behavior that demonstrates whether the learning has occurred.
3	Purpose	This states why the student should accomplish the learning objective. Whenever possible, it should refer to how the new learning is related to prior and future learnings to facilitate positive transfer and meaning.
4	Input	This is the information and the procedures that students will need to accomplish the learning objective. It can take many forms, including reading, lecture, cooperative learning groups, audiovisual presentations, and so on.
5	Modeling	Clear and correct models help students make sense of the new learning and establish meaning. Models must be given first by the teacher and be accurate, unambiguous, and non-controversial.
6	Check for Understanding	This refers to the strategies the teacher will use during the learning episode to verify that the students are accomplishing the learning objective. The check could be in the form of oral discussion, written quiz, or any other overt format that yields the necessary data. After these checks, the teacher may provide more input, reteach, or move on.
7	Guided Practice	During this time, the student is applying the new learning in the presence of the teacher who provides immediate feedback on the accuracy of the learner's practice.
8	Closure	This is the time when the mind of the learner can summarize for itself its perception of what has been learned. The teacher gives specific directions for what the learner should mentally process and provides adequate time to accomplish it. This is usually the last opportunity the learner has to attach sense and meaning to the new learning, both of which are critical requirements for retention.
9	Independent Practice	After the teacher believes that the learners have accomplished the objective at the correct level of difficulty and complexity, students try the new learning on their own to enhance retention and develop fluency.
Not every lesson needs every component. The teacher should choose the components that are relevant to the learning objective.		

Taken from How the Brain Learns by David Sousa, 1995, p. 131-132

Appendix M

Lesson Component's Relationship to Research			
Lesson Component	**Purpose**	**Relationship to Research**	**Example**
Anticipatory Set	Focuses students on the learning objective.	Establishes relevance and encourages positive transfer during first prime time.	Think of what we learned yesterday about prefixes and be prepared to discuss them.
Learning Objective	Identifies what learning outcomes are to be accomplished by end of lesson.	Students know what they should learn and how they will know they have learned it.	Today we will learn about suffixes.
Purpose	Explains why it is important to accomplish this objective.	Knowing the purpose for learning something builds interest and establishes meaning.	Learning about suffixes will help us understand more vocabulary and give us greater creativity in writing.
Input	Gives students the information and skills they need to accomplish the objective.	Bloom's knowledge level. Helps identify critical attributes.	Suffixes are letters placed at the ends of words to change their meaning.
Modeling	Shows the process or product of what students are learning.	Modeling enhances sense and meaning to help retention.	Examples are: -less, as in helpless; -able, as in drinkable ; and -ful, as in doubtful
Check for Understanding	Allows teachers to verify if students understand what they are learning.	Bloom's comprehension level.	John, tell me what you have learned so far about the meaning and use of suffixes.
Guided Practice	Allows students to try the new learning with teacher guidance.	Bloom's application level. Practice provides for fast learning.	Here is a list of 10 words. Add an appropriate suffix to each and explain their new meaning.
Closure	Allow students time to mentally summarize and internalize the new learning.	Last chance for attaching sense and meaning, thus improving retention.	I'll be quiet now while you think about the attributes and uses of suffixes.
Independent Practice	Students try new learning on their own to develop fluency.	This practice helps make the new learning permanent.	For homework, add suffixes to the words on page 121 to change their meaning.

Taken from <u>How the Brain Learns</u> by David Sousa, 1995, p.134

Appendix N

Questions to ask while planning lessons		
Question		Rationale
1	What tactics am I using to help students attach meaning to the learning?	Meaning helps retention.
2	Have I divided the learning episode into mini-lessons of about 20 minutes each that don't exceed working memory's capacity?	Short lesson segments have proportionately less down-time than longer ones.
3	What motivation strategies am I using?	Motivation increases interest and accountability.
4	How will I verify if the students remember what they learned previously?	About 24 hours must pass to determine if what was previously learned is in long-term storage.
5	Which type of rehearsal should be used with this learning, and when?	Rote and elaborative rehearsal serve different purposes.
6	Am I using the prime-times to the best advantage?	Maximum retention occurs during prime-times.
7	What will the students be doing during down-time?	Minimum retention occurs during down-time.
8	Am I using instructional modes from the learning pyramid that produce the greatest retention?	Different instructional modes result in different rates of retention.
9	Does my plan allow for enough wait time when asking questions?	Wait time is critical to allow for student recall to occur.
10	What chunking strategies are appropriate for this objective?	Chunking increases the number of items working memory can handle at one time.
11	What related prior learning should be included for distributed practice?	Distributed practice increases long-term retention.
12	How will I maximize positive transfer and minimize negative transfer?	Positive transfer assists learning; negative transfer interferes.
13	Have I identified the critical attributes of this concept?	Critical attributes help distinguish one concept from all others.
14	Are the concepts too similar to each other?	Concepts that are too similar should not be taught together.
15	How will I show students how they can use (transfer) this learning in the future?	The prospect of future transfer increases motivation and meaning.
16	Is it appropriate to use a metaphor with this objective?	Metaphors enhance transfer, hemispheric integration, and retention.
17	Have I included activities that are multi-sensory and engage both hemispheres?	Using many senses and both hemispheres increases retention.
18	Would a concept map help here?	Concept maps help hemispheric integration and retention.
19	How will I move this objective up Bloom's Taxonomy?	The taxonomy's upper levels involve higher-order thinking skills.
20	What emotions (affective domain) need to be considered or avoided in learning this objective?	Emotions play a key role in student acceptance and retention of learning.

Taken from How the Brain Learns by David Sousa, 1995, p.135