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ABSTRACT

While the ARCS (Attention, Relevance, Confidence, Satisfaction) model has provided educators with a heuristic approach to generally increasing the motivational appeal of instruction, it may also provide a model for stimulating and sustaining curiosity in particular. Such a model is of great use to educators who are concerned with encouraging curiosity as a prime intrinsic motivator for learning and to designers of computer-based systems who wish to incorporate specific strategies for arousing and sustaining the curiosity of users. This conceptual paper explores the construct of curiosity and examines its relationship to all of the ARCS components. A review of research on curiosity includes curiosity as a state of arousal leading to exploratory behavior; levels of arousal; specific, diversive, trait and state nature of curiosity; curiosity as it relates to elementary school children; the importance of information seeking, processing, and evaluating behaviors; sensory and cognitive curiosity; feedback; and correlation between curiosity and Intelligence Quotient. The relationship of curiosity to each of the ARCS components is examined. Discussion includes strategies for gaining and sustaining attention, external motivation, tying instruction to the learner's experiences, informative feedback and anxiety reduction, and the ARCS components in relation to the Zone of Curiosity. (Contains 46 references.) (AEF)

Title:

Arousing and Sustaining Curiosity: Lessons From The ARCS Model

Authors:

Marilyn P. Arnone
Vice President
Creative Media Solutions
Syracuse, New York

and

Ruth V. Small
Assistant Professor
School of Information Studies
Syracuse University

Abstract

While the ARCS Model has provided educators with a heuristic approach to generally increasing the motivational appeal of instruction, it may also provide a model for stimulating and sustaining curiosity in particular. Such a model is of great value to educators who are especially concerned with encouraging curiosity as a prime intrinsic motivator for learning and to designers of computer-based systems who wish to incorporate specific strategies for arousing and sustaining the curiosity of users. This conceptual paper explores the construct of curiosity and examines its relationship to all of the ARCS components.

Introduction

"To be uncurious is to have no antennae picking up the future's signals. To be curious is to find that an inquiry into one subject soon has others beckoning" (Weintrub, 1986). The importance of curiosity in motivating scholarship cannot be ignored. Curiosity has been revisited as a topic of interest recently, especially as it relates to the design of interactive computer-based instruction (eg., Rotto, 1994, Arnone & Grabowski, 1994, Arnone & Grabowski, 1992). Research indicates that keeping learners in what Day (1982) calls a "Zone of Curiosity" should result in increased learning and a sense of intrinsic satisfaction. Accomplishing that, of course, is quite a challenge.

Educators and designers often incorporate curiosity-arousing strategies into instruction in a haphazard fashion, when what they really need is a cohesive model with theoretical underpinnings for the selection and implemenation of such strategies. Perhaps a new model should be developed for specifically addressing curiosity, or, is it possible that one already exists which would work well with the construct of curiosity even though it was developed for a more general application to motivational design? Such a model would have great value to educators who are especially concerned with encouraging curiosity as a prime intrinsic motivator for learning and to designers of computer-based systems who wish to incorporate specific strategies for arousing and sustaining the curiosity of users. The purpose of this conceptual paper is to first explore the construct of curiosity and then to examine a leading motivational design model for its appropriateness as a heuristic approach for sustaining curiosity in particular.

Background on Curiosity

The seminal mind in the study of curiosity is Daniel Berlyne. He was thought to have epitomized in his own academic life what is meant by curiosity and intrinsic motivation (Furedy & Furedy, 1981). Berlyne died before his work was complete but his accomplishments were influential in much of the research in curiosity which followed including that of Day (e.g., 1968, 1982) and Maw and Maw (e.g., 1964, 1965, 1966, 1977). The theoretical groundwork Berlyne laid can be seen in much of today's explorations into curiosity both experimentally and conceptually (e.g., Loewenstein, 1994; Arnone & Grabowski, 1994; Rotto, 1994; Arnone & Grabowski, 1992). Other work including that of Beswick (1968) and Langevin (1971) as well as some of the more recent researchers in the field of intrinsic motivation (e.g., Malone, 1981; Csikszentmilhalyi, 1990; Keller, 1987) will be explored in relation to the study of curiosity.

In Berlyne's neurophysiological theory, curiosity is a state of arousal brought about by complex stimuli and uncertainty in the environment, leading to exploratory behavior. He identified two forms of exploratory behavior, diversive exploration and specific exploration, postulating that individuals seeking relief from changelessness or boredom would engage in diversive exploration while those wishing to resolve a conceptual conflict would engage in specific exploration. Berlyne called the motivator for specific exploration "epistemic curiosity," the motivational variable and drive associated with an individual's "quest for knowledge" (Berlyne, 1960). He postulated that the reception of knowledge and its subsequent rehearsal would reduce the drive (1954).

Important to Berlyne's theory is the notion of collative variability which refers to the complexity of a stimulus and the level of difficulty it presents to an individual in comparison to stimuli which are already familiar. Collative properties such as unfamiliarity, novelty, complexity, ambiguity, and incongruity (all conditions of stimulus uncertainty) may increase arousal level and induce curiosity. Presented with a stimulus with a moderate degree of uncertainty, an individual is motivated to make sense of this environment. He thus engages in exploratory behavior (e.g. information seeking/processing/evaluation) generally resolving any conceptual conflict, and returns to what Berlyne refers to as the "tonus level." It is at this moderate, pleasurable level of stimulation that an individual functions most effectively. The optimal level of arousal (where the individual is "curious") is somewhere just above the tonus level. Small increases in stimulation are considered pleasurable because of the resultant return to one's tonus level one experiences once the conflict is resolved.

Day (1982), a research colleague of Berlyne, describes the optimal level of arousal as one in which an individual enters a "Zone of Curiosity" (see Figure 1). With too much uncertainty (caused, for example by too much stimuli or stimuli too high in collative variability), the individual becomes overwhelmed or anxious entering what he refers to as a "Zone of Anxiety." With too little stimulation, on the other hand, the result is disinterest and demotivation often characterized by boredom. In either case, the individual is likely to withdraw from the exploratory behaviors before resolving his conceptual conflict. The degree of importance an individual places on the situation will also play a part in whether an individual's conflict leads to curiosity or to fear and/or anxiety (Berlyne, 1960, Day & Berlyne, 1971).

1).

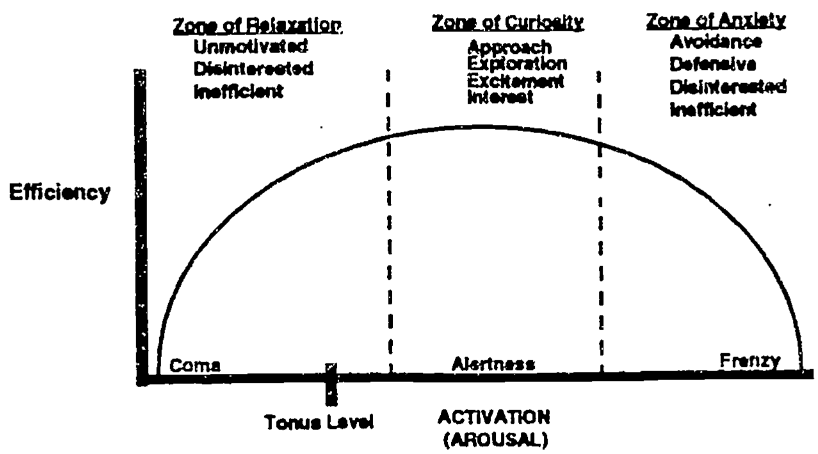

Figure 1: Day's Zone of Curiosity (1982) - The Optimal Level Of Arousal

Both Day and Berlyne (1971) agree that individuals differ in their tolerance and preference for arousal potential, suggesting that curiosity is both a state and a trait variable. What one individual may find optimally arousing, another may find overwhelming or the other extreme, understimulating. Preference for arousal potential can vary from individual to individual and from occasion to occasion. "How much arousal potential of a particular kind an individual will tolerate depends not only on the level of arousal tonus but also on how promptly and easily he has been able to assuage the arousal induced by similar conditions in the past" (Berlyne, 1960, p. 212). Berlyne maintains that "The teacher must, therefore, not only be astute in manipulating the environment but must also be aware of individual differences in tolerance for arousal change" (p. 328).

Building on Berlyne's distinction between specific and diversive exploration, Day developed and validated tests of specific and diversive curiosity. His Test of Specific Curiosity was a 36-item measure which he administered to children in a number of studies (e.g., Day, 1968). He decided, however, that the scale was too brief and narrow and eventually developed the more comprehensive and much used Ontario Test of Intrinsic Motivation (OTIM) (1968).

Maw and Maw (1964) operationalized a definition of curiosity as it relates to elementary school children building on the work of Berlyne. Maw and Maw asserted that "... curiosity is demonstrated by an elementary school child when he:

1. reacts positively to new, strange, incongruous, or mysterious elements in his environment by moving toward them, by exploring, or by manipulating them
2. exhibits a need or a desire to know more about himself and/or his environment
3. scans his surroundings seeking new experiences
4. persists in examining and exploring stimuli in order to know more about them" (p. 31).

It should be noted that their definition included both diversive and specific curiosity #1, #2, and #4 relating to specific curiosity and #3 relating to diversive curiosity. Day also used their operationalized definition in devising his Test of Specific Curiosity but since he was primarily investigating specific curiosity, he eliminated #3. Maw and Maw's definition of curiosity has proved useful over the years and is frequently used even in recent curiosity studies (e.g., Alberti & Witryol, 1994).

Maw and Maw conducted many studies in their development of pyschometric measures for trait curiosity. They tested the validity of their measures by first establishing criterion groups of high and low curiosity children and then testing whether the measures of curiosity they developed discriminated between the two groups. The means used to establish these groups included teacher judgements, peer judgements, and self judgements of curiosity. The authors found that teacher and peer judgements were not significantly affected by factors such as popularity, race, or sex. Intelligence had to be statistically controlled, however, as both teacher and peer judgements were significantly related to intelligence. When the children in the tentative criterion groups were investigated in terms of their self-judgements of curiosity, it was found that overall the children in the higher curiosity group rated themselves higher in curiosity than those in the low group. The difference between the means was significant at $p = .005$. Maw and Maw used these groups to validate items for their various measures, one of which was the Which To Discuss Test. This particular measure also had fairly high reliability using Cronbach's alpha as a measure of internal consistency, $r = .90$. It has been utilized in numerous studies (e.g. Silverstein, Pearson, Dunnick & Ford, 1981; Beer, 1986; Beer & Beer, 1986, Arnone & Grabowski, 1992; Kerr & Beer, 1992; Arnone & Grabowski, 1994).

Maw and Maw also used question-asking behavior as a measure of curiosity. In one study, children were presented with pictures such as an odd animal, for example, and were then instructed to ask as many questions as they could think of about the pictures. It was found that children who had been previously identified as high curious asked more questions and had more independent ideas than low curious children (1964). A number of other researchers have developed measures of curiosity including Penny and McCann (1964), Naylor's state and trait measures (1981), Vidler and Rawan's Academic Curiosity Scale (1974, 1975), Langevin's Experiential Curiosity Measures (1971), and so on.

While Day, Maw and Maw, and many researchers have subscribed to the basic tenets put forth in Berlyne's theory, not everyone agreed with his theoretical explanation of curiosity. For example, Beswick (1968) proposed a cognitive process theory of curiosity in which an individual receives input (signals) which is taken into his cognitive map or category system (representing all previous experience and learning), and then is coded for meaning. If the individual experiences difficulty in the coding operation, he would engage in assimilation (to modify the signal) and/or accommodation (to modify the category system). Accommodation, then, represents new learning. Beswick asserts that individual differences in curiosity are a function of category system characteristics and differences in one's coding operation as they relate to a conceptual conflict. He states that different people will have different probabilites of coding difficulties depending on the particular situation. One uses different "strategies" for dealing with uncertainty. Curiosity, then, is a preferred cognitive strategy. Highly curious individuals have an "acquired predisposition to increase, prolong, and resolve conceptual conflicts" (p.). According to Beswick, a highly curious person expects a pleasurable integration of the signal with his or her category system and finds this preferred cognitive strategy to be intrinsically rewarding. Still, Beswick uses many of the same concepts as Berlyne and others such as uncertainty, conflict, arousal, and "pleasurable" (in reference to integration in Beswick's theory and stimulation in Berlyne's theory) to explain curiosity.

H. Carl Haywood also took exception to Day's reliance on explaining motivation only in terms of tension-reduction, suggesting that explanations for motivation may also be inherent in information processing (1968). Malone (1981) argues that it is the kind of complexity or incongruity of the information rather than the amount that is motivating and that there is some optimal level of information complexity that can be tolerated. Steers & Porter (1987) state that central to an explanation of arousal "is the idea that the individual cognitively processes and evaluates a lot of information and that motivation is linked strongly to this information processing activity" (p. 33). Olson, Camp, and Fuller (1984) found a strong positive correlation between "need for cognition," defined as the dispositional tendency to engage in and enjoy thinking (p. 71) and curiosity. Most recently, Alberti and Witryol (1994) have argued that cognitive development is enhanced by curiosity and exploration because they expose a person to a "greater variety of experiences in which learning can occur" (p. 129).

Given that there is a cognitive component to curiosity, the importance of information seeking, processing, and evaluation behaviors must be considered. Without sufficient and/or relevant information, the individual will likely have great difficulty in resolving the cognitive conflict the situation presents, thereby experiencing a dramatic decrease in or even extinction of curiosity.

Consider this example. Sarah's curiosity is piqued when her teacher presents a lesson on the rainforests of South America, leaving several unanswered questions at the conclusion of the class (but promising answers the following day). Immediately following the lesson, Sarah goes to the school library media center and peruses the online catalog for materials on this topic. When she finds none, she is highly disappointed, abruptly ends her search, and returns to her classroom unsatisfied. Only if she persists (e.g. going to another library) or there is an external intervention (e.g. the librarian assists her), might her curiosity be rejuvenated to its former level. Her persistence may have been tempered by another factor, importance of the information. Since Sarah had been told that the answers to these questions would be provided the next day, it was likely not as important as it would have been if the questions were not soon going to be addressed. Importance is addressed by the following theorist.

Lanzetta (1968) states that both uncertainty and importance contribute "to the magnitude of conflict and thus to the strength of the motive to search for information" (p.), what he calls the "motivation to acquire information" (p.). As such, uncertainty reduction is the reinforcement for information searching and a preference for sources of information of high uncertainty reduction potential. The motive to reduce uncertainty was also related to curiosity in one of Kagan's (1972) four basic human motives.

Malone (1981) differentiates between sensory curiosity and cognitive curiosity, terms somewhat analogous to Berlyne's perceptual and epistemic curiosity. Sensory curiosity involves enriched learning environments (e.g. animations, brightly-colored illustrations, music) that provide sensual stimulation; where, cognitive curiosity is stimulated when a learner's environment is incomplete, inconsistent, and unparsimonious, motivating him to learn more in order to improve his "cognitive structure" (p. 363). Malone recommends providing informative feedback as a means of helping a cognitively curious learner.

Loewenstein (1994) also argues the importance of feedback in his recently developed "information-gap" theory of specific epistemic curiosity. He acknowledges the works of earlier theorists in the field in the development of his own theory. Curiosity, according to Loewenstein, is a feeling of deprivation which occurs as an individual recognizes a gap in his/her knowledge and is motivated to seek the information that will ameliorate the feeling of deprivation. The information gap is effectively the difference between "what one knows and what one wants to know" (p. 87). He also proposed that as a person's knowledge of a particular domain increases, his/her awareness of information gaps in that knowledge will also increase, thus setting up a necessary condition for curiosity to occur. In this perspective, a person would be predicted to experience "a sudden increase in curiosity when the individual becomes focused on the missing information and then a more gradual increase as he or she approaches the goal of closing the information gap" (p. 89). Relating all this back to feedback, Loewenstein asserts that one must have an *awareness* of an information gap to experience curiosity and that accuracy feedback is one way of helping a person understand what he/she does not know. In the absence of feedback, and with an unrealistic view of one's knowledge (i.e., an individual thinks he/she knows more about a topic that he/she actually does), curiosity for the topic may be decreased or eliminated.

Whether one takes Berlyne and Day's more neurophysiological view, Beswick and others' more cognitive view, Malone's dualistic view, or our more integrative view that recognizes the importance of both neurophysiological and cognitive factors for the explanation of curiosity, it appears that the amount of uncertainty involved and one's personal tolerance for (or strategies for dealing with) a curiosity- arousing situation will affect an individual's response to the source of stimulation (arousal), input (signals), and so on.

Although it is often presumed that intelligence and curiosity go together, most of the studies reviewed showed low or nonsignificant correlations between curiosity and IQ. Langevin overall found IQ to be distinct from curiosity with the exception of the Teacher Rating Test which had significant correlations with the Otis Intelligence Test and the Raven ($r = .3524$, $r = .3263$ respectively, $p = .01$). Day and Berlyne (1971) issue a caution about teacher judgements. Even if provided with a list of behaviors that represent curiosity, there is still a tendency to judge the highest ability students as the most curious. This was shown in a study which found that teacher ratings of curiosity related to achievement scores but not to a measure of novelty used to assess curiosity in third and fifth grade children (Alberti & Witryol, 1994).

In a study involving subjects in grades 7, 8, and 9, Day (1968) predicted that a measure of specific curiosity which measured the subject's intent to approach high levels of visual complexity and to withdraw from low levels of visual stimulation would not correlate with IQ; he found no significance (r = .01) as expected. In another of his experiments on specific curiosity (1968), 429 subjects in grades 7, 8, and 9 from the same school system participated in a study in which he administered his Test of Specific Curiosity and again found no significance in the correlation between his measure and IQ (r = .01).

No significant differences in IQ level between high and low curious subjects were found in a study by Maw and Maw (1965) in which differences in preferences for investigatory activities between high and low curious children were investigated. A study by Henderson and Gold (1983) also lent support for curiosity as being distinct from intellectual power. Henderson and Wilson (1991) failed to support a relationship between measures of curiosity and intelligence in preschool children. They offered one possible explanation that perhaps the relation between these constructs was not concurrent but rather predictive. To test this developmental view, they called for longitudinal studies that "investigate the ability of individual differences in curiosity at time 1 to predict changes in acquisition of knowledge (e.g., intelligence or achievement) from time 1 to time 2" (p. 173).

Alberti and Witryol's (1994) study of curiosity and cognitive ability, based on a similar view that curiosity enhances cognitive development, did, however, show an overall significant positive correlation between a curiosity measure (preference for short-term novelty) and standardized achievement measures in their sample of elementary school aged children. If there is such a relationship between curiosity and cognitive development, then there is good reason to encourage curiosity at home and in school.

One problem with the study of curiosity is that there doesn't appear to be any one "C" (curiosity) factor that we can feel comfortable about saying encompasses the construct entirely. In fact, curiosity seems so multidimensional that it should not even be considered a unitary construct. Yet it is often treated as such, especially in studies where curiosity is only an ancillary variable. Langevin (1971) compared a number of curiosity measures and two intelligence measures and found that while most of the measures were distinct from intelligence measures, several were also somewhat distinct from each other indicating that perhaps their validity should be addressed. Henderson and Wilson (1991) encountered a similar problem when their measures of curiosity did not correlate significantly with each other. They suggested that the curiosity measures may not have been adequate indicators of curiosity, or again that their measures were testing different things. It is easy to see from just the brief sampling of theoretical and empirical works reviewed that curiosity can be considered both a state and a trait, and specific and diversive. With this in mind, researchers must be cautious not to take for granted a more simplistic, all-encompassing construct called "curiosity," but rather to think of it in more complex terms. Figure 2 attempts to graphically represent the multifaceted nature of curiosity.

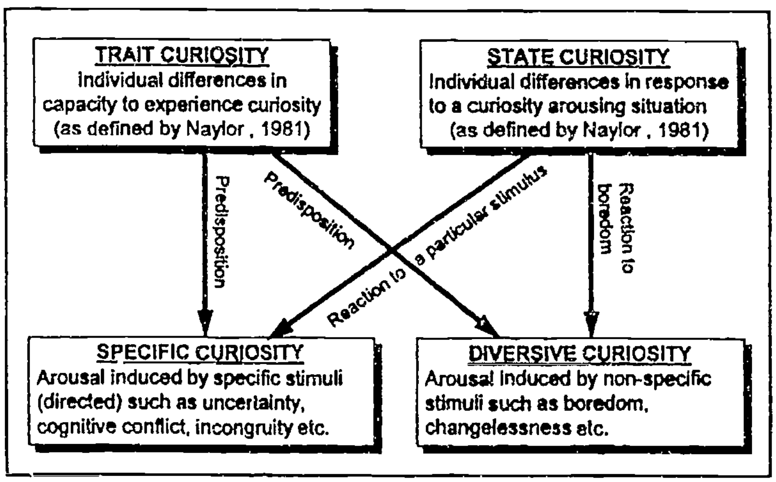

Figure 2: Multifaceted Nature of Curiosity

Figure 2. The Multifaceted Nature of Curiosity

Several writers and researchers (e.g., Rotto, 1994; Rezabek, 1994) have also begun to explore the Flow Theory of Csikszentmihalyi (1990) and its relationship to motivation and curiosity. Flow is described a state of intense intrinisic motivation, a natural high such as what athletes describe when they are intensely engaged in their sport. It is an "optimal experience" characterized by clear goals and feedback, challenges that are matched to skills, a merging of action and awareness, highly focused concentration, a sense of potential control, an altered perception of time, a sense of growth, and the engagement in an action simply for its own sake (Csikszentmihalyi, 1983). Flow can occur during work activities or leisure activities but Csikszentmihalyi reports its occurence more often during work activities than leisure activities although individuals are more motivated during leisure activities (Csikszentmihalyi & LeFevre, 1989). Flow experiences can happen at home, in conjunction with hobbies, sports, and even during more passive activities -- anytime when challenges and skills are approximately equal.

Could what Csikszentmihalyi calls optimal challenge resemble what Berlyne and others have referred to as the optimal level of arousal necessary for curiosity to be sustained? It would seem that at least some aspects of sustaining a state of curiosity would resemble those in a flow state. However, the construct of curiosity, at least epistemic curiosity, involves some kind of conceptual conflict which must be resolved. In flow, while challenge is necessary, conflict is not. Malone (1981) explains that Csikszentmihalyi focuses on the role of challenge in intrinsic motivation but omits mentioning the importance of curiosity because he is not dealing specifically with a learning context.

John Keller's work (e.g. 1979; 1983) has focused on the importance of motivation in instruction and learning. Keller has developed the ARCS (Attention, Relevance, Confidence, Satisfaction) Model of Motivational Design, based largely on Porter and Lawler's (1968) Expectancy-Value Theory, but also incorporating a number of other motivational variables (e.g. locus of control, need for achievement). Keller (1979) cites the importance of curiosity as a motive to reduce uncertainty, "a person's responsiveness to incongruity and uncertainty" (p. 31) and uses it as the primary theoretical basis of the attention component of his model. He recommends a judicious application of instructional strategies that arouse, maintain, and/or increase curiosity (e.g. presenting novel, incongruous, or paradoxical events, posing a perplexing problem, and using analogies).

The ARCS Model and Curiosity: Is There a Fit?

While Keller's model is designed to raise the overall motivational level for instruction (including both intrinsic and extrinsic motivation), each component of the model may contribute to the arousing and sustaining of curiosity. The problem has been that typically curiosity is linked to the attention component, so that parents and teachers sometimes overlook the value of the other components in encouraging curiosity as a prime motivator for learning. In this section, we will attempt to show the "fit" between the ARCS model and both the arousal and sustaining of curiosity.

Let's begin by briefly returning to the theoretical underpinnings of the ARCS Model. As noted earlier, one of the dominant theories upon which the ARCS Model is based is Expectancy-Value (E-V) theory (e.g., Porter & Lawler, 1975). E-V theory posits that motivation occurs as a result of both one's expectancy for success and one's perception that a particular activity will be personally rewarding. Keller makes a direct link between the value dimension and research in the area of curiosity (1983). Expectancy for success factors into curiosity as well. For example, Loewenstein's Information Gap Theory holds that "people will be more curious to know something if they think it is knowable" (p.93). Keller states that the value dimension is most closely related to his attention and relevance components while the expectancy dimension of E-V theory is most closely alligned with the confidence and satisfaction components (Keller, 1979). This distinction was supported in a recent study by Small and Gluck (1994).

Although curiosity is primarily associated with the attention component, we assert that every component of ARCS (i.e., attention, relevance, confidence and satisfaction potential) contributes to an explanation of the successful arousal and sustaining of curiosity and an eventual resolution of its underlying conflict. In order to keep an individual in Day's (1982) Zone of Curiosity, it may be necessary to incorporate all of the components into instruction. Since learners bring many individual differences to a learning situation, however, any model is necessarily heuristic as opposed to prescriptive.

Rotto (1994) notes, if the curiosity-arousing situation does not "show promise of being useful, moderately non-threatening, and of being rewarding, we will not be led to explore it in any extended way (p. 6)." This would seem to be true if you think of the state of curiosity as being one in which the individual is at an optimal level of arousal, thereby focusing all his attention toward a particular stimulus. The individual must then experience a desire to resolve a conflict (i.e., the conceptual conflict has some relevance to him), be confident that the conceptual conflict can be resolved and that he/she is capable of resolving it, and have a sense that there is potential for satisfication once the conflict is resolved. For curiosity to be sustained (e.g., the exploratory behaviors persist for long periods of time, and/or the learner experiences repeated occurrences of curiosity within the same teaching/learning episode), then, in addition to attention, there must be relevance, confidence, and satisfaction potential. Integrating Day's (1982) and others theoretical view of curiosity, and Keller's ARCS model, Figure 3 attempts to depict the relationship between the ARCS components and arousing and sustaining curiosity.

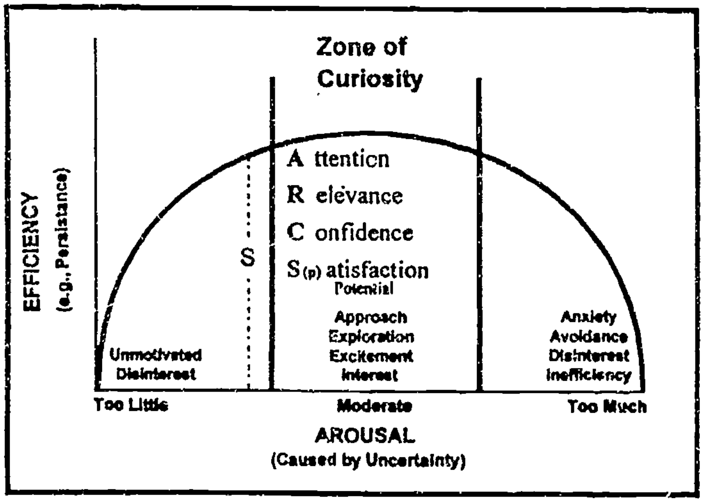

Figure 3: Adapted from Day (1982)

Figure 3. Adapted from Day (1982)

Curiosity and Attention. Keller (e.g., 1983) describes a relationship between curiosity and the attention component of his model and suggests a number of strategies for gaining and sustaining attention, such as novelty, surprise, incongruity, ambiguity, etc. These same elements have been described in prior curiosity research as properties of collative variability which are representative of uncertainty and useful in inducing curiosity.

Consider the following example. At Miami's Central High School, Ms. Adams, the chemistry teacher, describes how, according to scientific law, the combination of chemical X and chemical Y should turn the litmus paper blue. Later in chemistry lab, Jim conducts an experiment in which he mixes the two chemicals and inserts litmus paper, but upon withdrawing the paper finds that it has turned red. He is surprised by this unexpected outcome, his curiosity is aroused and he turns his attention to searching for the cause.

Figure 4 builds on Day's Zone of Curiosity and represents a situation in which there is no learner attention. Learner attention is a prerequisite to the establishment of relevance, building of confidence, and recognition of satisfaction potential. When attention is absent, the learner (indicated by an X) *never* enters the zone of curiosity, remaining instead in a zone of disinterest.

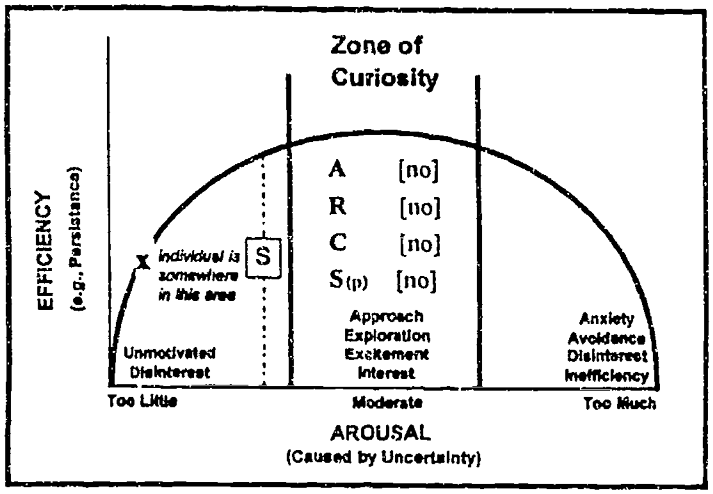

Figure 4: No A (curiosity is not aroused), therefore no chance for R, C, or $S_{(p)}$

Figure 4. Situation Lacking Attention Prohibits Relevance, Confidence, and Satisfaction Potential

Curiosity and Relevance. To keep one in a zone of curiosity (at least when discussing state epistemic curiosity), the second ARCS component, relevance, also comes into play. Perceived value (personal relevance) has been shown to be significantly related to the decision to seek additional knowledge in young and middle-aged adults (Camp, Rodrigue, & Olson, 1984). Loewenstein (1994) acknowledges the role preexisting interests play in elevating one's informational reference point which is synonomous with what a person wants to know. Curiosity occurs when one's "informational reference point in a particular domain becomes elevated above one's current level of knowledge" (p. 89). This suggests that educators increase their chances of stimulating curiosity when they give learners choices (reflecting personal interests) which is a recommended relevance strategy in the ARCS Model. Loewenstein's information-gap perspective of curiosity also predicts that curiosity increases as knowledge of a domain increases given that the objective *value* of the missing information remains the same (p.90). It would seem, then, that relevance can be increased by introducing a curiosity-arousing situation which has at least some familiarity to the learner (that is, the learner already has some knowledge about it). The relevance component of the ARCS Model reflects the importance of familiarity and tying instruction to the learner's experiences.

Relevance may even occur naturally (that is, without any external intervention) as awareness of a gap in one's knowledge becomes apparent. Also, in line with Beswick's (1968) cognitive processing model, any stimulus event or "signal" that is at odds with one's existing "cognitive map" is likely to automatically become more relevant. Considering this, attention and relevance go hand in hand. If an attention strategy such as introducing incongruity is used for a particular instructional purpose, it should, in addition to *arousing* curiosity, lead to increasing the importance to the learner of continuing her search until there is no longer incongruity, thus *sustaining* curiosity. This is consistent with Lanzetta's (1968) emphasis on uncertainty (attention-related) and importance (relevance-related) as critical to the motivation to acquire information.

Returning to our example, Jim continues to explore the possible factors that contributed to the result of his experiment because he feels a need to close his information gap and explain (and potentially correct) the unexpected outcome. Therefore, even when a learner's attention is aroused and he feels confident that he can resolve the uncertainty or incongruity (and thereby satisfy his curiosity), if relevance is lacking then curiosity, which is intrinsic in nature, cannot be sustained (see Figure 5). As a result, the learner perceives no potential for satisfaction and becomes unmotivated and disinterested. Persistence in the activity will likely be prolonged only if it is connected to some external motivation, such as a raise in pay or a high grade, a motive which no longer can be considered curiosity.

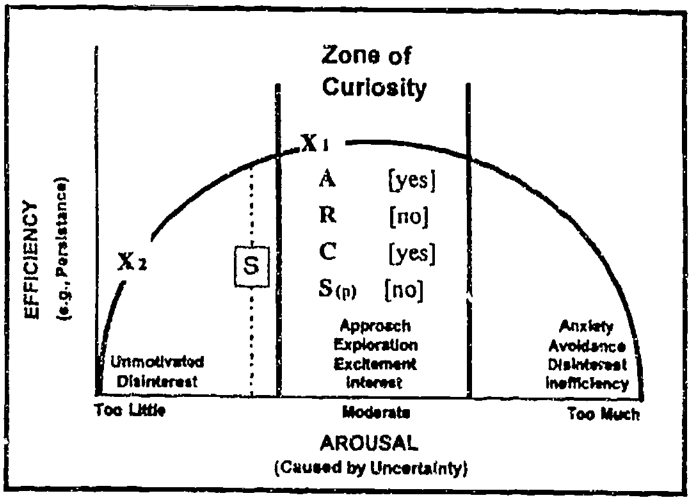

Figure 5: A, C, but no R and hence no $S_{(p)}$

Figure 5. Attention and Confidence Without Relevance Results in Lack of Satisfaction Potential.

Curiosity and Confidence. Even if a learner finds particular instructional materials or events initially arousing and somewhat relevant, it is unlikely that curiosity will be sustained without some confidence that she will be able to resolve the conflict. If, on the other hand, the learner feels confidence that she can resolve a particular conceptual conflict, she is likely to stay in a zone of curiosity, manipulating or exploring the environment. For example, dealing with ambiguity entails seeking needed information through exploratory and epistemic behavior, but as Berlyne (1960) notes "this means that the conflict must be faced and born for a while" (p.216). A study Berlyne described in his famous book "Conflict, Arousal, and Curiosity" found a positive correlation between tolerance for ambiguity and self-confidence. Tolerance for complexity could also play a part in whether curiosity is sustained or extinguished. Yerkes & Dodson (1908) found that if a task is too difficult, motivation decreases. If a conceptual conflict proves too complex or difficult, one could likewise expect curiosity to decrease. The confidence component of the ARCS Model suggests strategies for dealing with difficulty level of materials which could be modified to address curiosity in particular.

Anxiety may play a part in undermining one's confidence and in cutting short one's time in the zone of curiosity to which Day (1982) refers. Anxiety reduction is also addressed under this component of Keller's Model with one suggestion being that confirmational and corrective feedback will assist in reducing anxiety; this would result in extending the time one is willing to spend in the zone of curiosity. The use of informative feedback has been associated with the reinforcement of curiosity (Malone, 1981). If, in our example, Ms. Adams provides Jim with some verbal cues about his perplexing problem and suggests additional books and other information resources, Jim may feel more confident that he will resolve his curious situation.

While flow theory addresses intrinsic motivation and not specifically curiosity, it could be hypothesized that, in some cases, a sustained state of curiosity may evolve into a "flow" state in the process of resolving a conceptual conflict. As our friend Jim delves into the various information resources, he may become so absorbed that he experiences flow. Challenges and skills are important to flow theory, challenge and curiosity have been linked (Malone, 1981), and they both seem to be related to the concept of self-confidence. In the confidence component of the ARCS Model, challenge levels (e.g., deciding on an appropriate challenge level for a particular audience) are addressed, as well as building feelings of competence and positive expectations for success.

So, if a situation occurs in which both attention and relevance are present but the learner believes the curiosity-arousing situation is too difficult or complex, the learner may lack confidence to continue. Without confidence, and in the presence of a stimulus with a high degree of uncertainty, the individual will likely fall back into a zone of disinterest or fall forward in a zone of anxiety, eventually withdrawing from the exploratory behaviors as the curiosity quickly diminishes. In this scenario, satisfaction potential disappears (see Figure 6).

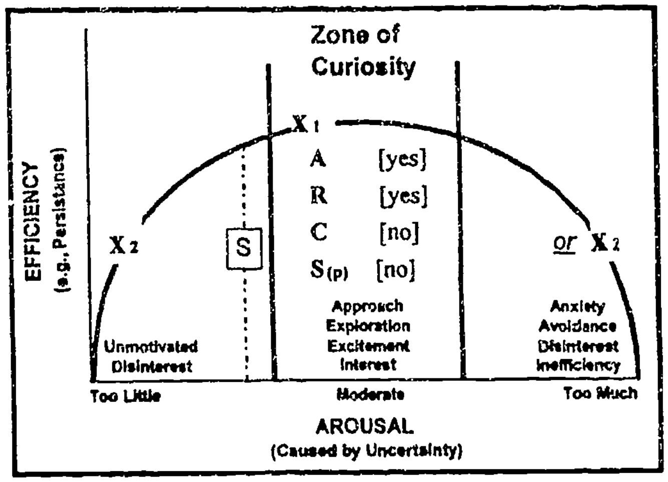

Figure 6: A, R, but no C, $S_{(p)}$

Figure 6. Attention and Relevance Present But No Confidence And Therefore No Satisfaction Potential.

Curiosity and Satisfaction Potential. Satisfaction potential must be high in order for an individual to remain in a curiosity state. If there is only a slim chance for satisfying one's curiosity, it is unlikely that an individual will expose himself to a curiosity inducing situation (Loewenstein, 1994). Since the curiosity-invoking situation produces an aversive state of tension and uncertainty, the potential for satisfaction resulting from its reduction is correspondingly high. According to Berlyne and Day, upon the actual resolution of a curiosity arousing situation the individual returns to his/her tonus level. Loewenstein writes: "The pleasure derived from satisfying curiosity provides a simple explanation for voluntary curiosity seeking. It is perfectly sensible for people to expose themselves to curiosity-inducing situations if the expected incremental pleasure from obtaining the information compensates for the aversiveness of the curiosity itself" (p.90). (This statement can also be related to the confidence component of the ARCS Model that addresses positive expectations for success as a motivator.) The fit with Keller's Model comes as he addresses intrinsic reinforcement under the satisfaction component. For Jim, then, an understanding of the cause of his experimental outcome has the potential for satisfaction (in keeping with several theoretical approaches) in the form of tension reduction, cognitive integration or closing his information gap, intrinsic feelings of accomplishment and competence, and praise from his teacher as an extrinsic bonus which is of less interest to us.

Only after the individual resolves the curiosity-invoking conflict will actual satisfaction occur. In our example, Jim experiences satisfaction when he reads in one of his sources that if even a small amount of chemical Z is added to chemicals X and Y, a different chemical reaction will occur. Jim remembers that during the last lab session, he had neglected to clean his beaker which had contained chemical Z. As a result, the beaker contained residue of chemical Z which, when mixed with the two chemicals in the experiment, caused the litmus paper to turn red rather than blue. After thoroughly cleaning the beaker, Jim tries the experiment again and obtains the expected result.

Figure 7 depicts the presence of all ARCS components. The result would be a sustaining of curiosity followed by a return to the pleasurable tonus level (equated to the satisfaction component of ARCS) once uncertainty is reduced (e.g., by resolving a conceptual conflict).

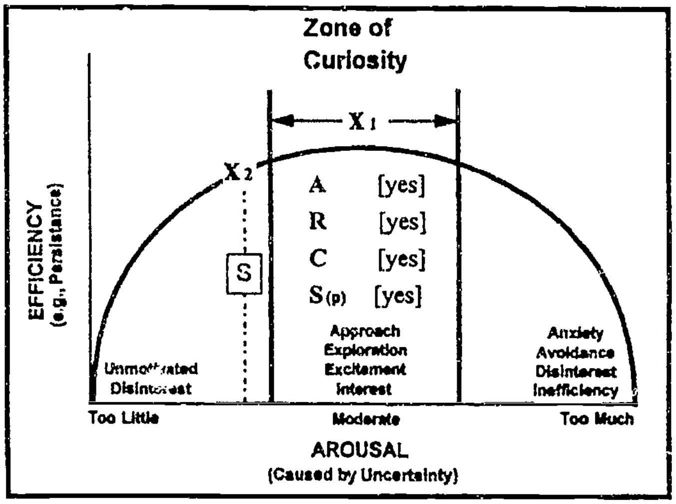

Figure 7: A, R, C, $S_{(p)}$ are all present

Figure 7. All ARCS Components Present, Satisfaction Occurs.

Design Recommendations

In this section of our paper, we include recommendations for arousing and sustaining curiosity in learning contexts using the ARCS Model of Motivational Design. For example, strategies in keeping with the first two components of ARCS, attention and relevance, can be used to introduce a conceptual conflict that has at least some relevance (any stimulus which differs from schema already accepted by the individual may suddenly become more relevant as he/she struggles to integrate it into existing schema). The third component comes into play as we design strategies which give the learner the confidence that he or she will be capable of resolving whatever conceptual conflict the instance of curiosity has engendered. Satisfaction potential in the context of curiosity refers to an individual's perceptions about the potential intrinsic rewards that will result from resolving the curiosity-invoking situation. Satisfaction, the last ARCS component, occurs when, after sufficient exploration (while in the zone of curiosity), one resolves the conceptual conflict and returns to the pleasurable tonus level. Satisfaction can take many forms including external rewards, but when stimulating curiosity is the motivational goal, it is in intrinsic satisfaction as a natural by-product of a curiosity-arousing situation that we are particularly interested.

The following section includes a number of curiosity-arousing and maintaining strategies related to each of the ARCS components that may be incorporated into an instructional design.

ARCS COMPONENTS	*RECOMMENDATIONS FOR AROUSING AND SUSTAINING CURIOSITY*
ATTENTION	•Use collative properties such as complexity, novelty, incongruity, contradiction, and ambiguity to provoke a cognitive conflict. •Create an atmosphere where learners feel comfortable about raising questions and where they can test their own hypotheses through discussion or brainstorming. •Be aware of the degree of stimulation which is entered into the learning situation. Anxiety may be induced if the stimulus is too complex, too uncertain, too novel. Boredom may result if there is too little stimulation. •Be senstive to individual differences in tolerance for curiosity arousal (notice which individuals approach new and/or different stimuli and which display avoidance behaviors). This should help you in determining how much uncertainty to introduce when attempting to arouse curiosity. •Help learners become aware of their information gaps in a particular topic area. •Minimize distractions that may have the effect of eliminating curiosity once aroused.
RELEVANCE	•Model curious behaviors to increase learners' perceptions of the importance of curiosity. •Allow students to become engaged and curious about topics or interests in which they already have some knowledge. •Have learners think about how they might feel once they have resolved the conceptual conflict. •Make statements that help learners to see the potential value in persisting in a curiosity-arousing situation until the necessary information has been found. Have them set their own personal information goals. •Provide opportunities for learners to choose alternative strategies for exploring curiosity-stimulating situations.

CONFIDENCE	•Make the challenge or conflict in line with learners' skills and abilities and at the appropriate level of complexity. •Provide informative feedback that will help learners see a realistic picture of their information gaps and reinforce their curiosity (reducing possible anxiety). •Help learners have positive expectations for success based on having clear goals (e.g., learner has a plan for seeking the necessary information to, as Loewenstein (1994) would say, close his/her information gap). •Encourage exploration and give learners opportunities to explore curiosity arousing situations in their own ways. •Support information-seeking activities. •Allow time for learners to persist in their explorations or information seeking.
SATISFACTION	*While satisfaction is a natural by-product of a curiosity-arousing situation once the conceptual conflict has been resolved, there are a number of strategies taken from Keller's Model which could provide additional satisfaction while setting the stage for future curiosity behaviors to occur. . .* •Bring attention to the intrinsic enjoyment that learners feel as a result of reducing the uncertainty connected with curiosity. •Be enthusiastic about the learners' accomplishments as they relate to curiosity. •Give learners an opportunity to reflect on their curiosity arousing episodes and their resolution. •Acknowledge any special challenges that may have been encountered in the process of resolving information uncertainty. •Provide the learner with additional materials about related areas of interest. •Inform learners if possible about ways in which they might continue to explore the area which was the source of their recent curiosity. •If one learner has resolved his/her uncertainty before others, allow him/her to provide guidance and informative feedback to others who are not yet there. *(Note the concentration on instrinsic reinforcement as opposed to extrinsic rewards)*

Summary

While the ARCS Model has provided educators with a heuristic approach to generally increasing the motivational appeal of instruction, it may also provide a model for stimulating and sustaining curiosity in particular, certainly an important challenge to today's educators and instructional designers. This paper has reviewed some of the research on curiosity, examined the relationship of curiosity to each of the ARCS components, and provided some ideas for stimulating and sustaining curiosity in learning contexts.

One of the greatest challenges of educators today is fostering intrinsic motivation in learners -- encouraging a love of and desire for lifelong learning. Research that provides a framework for designing instruction that stimulates and sustains curiosity may provide one giant step in that direction.

REFERENCES

Alberti, E. T. & Witryol, S. L. (1994). The relationship between curiosity and cognitive ability in third- and fifth-grade children. *The Journal of Genetic Psychology,* 155(2), 129-145.

Arnone, M. and Grabowski, B. (1994). Curiosity as a personality variable influencing learning in a learner controlled lesson with and without advisement. *Educational Technology Research and Development,* 42(1), 5-20.

Arnone M., and Grabowski, B. (1992). Effects on achievement and curiosity of variations in learner control in an interactive video lesson. *Educational Technology Research and Development,* 40(1), 15-27.

Beer, J. (1986), Specific and diversive curiosity in students in special education classes. *Psychological Reports,* 59, 307-309.

Beer, J., & Beer, J. (1986). Specific and diversive curiosity in mentally retarded adults. *Pyschological Reports,* 59, 846.

Berlyne, D.E. (1954). A theory of human curiosity. *British Journal of Psychology,* 45, 180-191.

Berlyne, D. E. (1960). Conflict, Arousal, and Curiosity. New York: McGraw-Hill Book Company.

Beswick, D. (1968). Cognitive process theory of individual differences in curiosity. In Day, D. Berlyne, & D. Hunt (Eds.) *Intrinsic Motivation: A New Direction in Learning.* Toronto: Rinehart and Winston of Canada.

Beswick, D., & Tallmadge, G. (1971). Reexamination of two learning style studies in the light of the cognitive process theory of curiosity. *Journal of Educational Psychology,* 62(6), 456-462.

Camp, C. J., Rodrigue, J. R., & Olson, K. R. (1984). Curiosity in young, middle-aged, and older adults. *Educational Gerontology,* 10, 387-400.

Csikszentmihalyi, M. and LeFevre, J. (1989). Optimal experience in work and leisure. *Journal of Personality and Social Psychology,* 56,(5), 815-822.

Csikszentmihalyi, M. (1990). *Flow: The psychology of optimal experience.* New York: Harper and Row.

Csikszentmihalyi, M. (1982). Toward a psychology of optimal experience. In L. Wheeler (Ed.), *Review of Personality and Psychology.* V2, pp 13-37. Beverly Hills, AA: Sage.

Day, H. (1968). Role of specific curiosity in school achievement. *Journal of Educational Psychology,* 59, 1, 37-43.

Day, H. I. (1968). The measurement of specific curiosity. In H. Day, D. Berlyne, & D. Hunt (Eds.) *I ntrinsic Motivation: A New Direction in Learning.* Toronto: Rinehart and Winston of Canada.

Day, H. I.. and Berlyne D. E. (1971). Intrinsic motivation. In G. S. Lesser (Ed.), *Psychology and Educational Practice.* Glenview, Illinois: Scott, Foresman and Company, 294-335.

Day, H.I., (1982). Curiosity and the interested explorer. *NSPI Journal,* May, 19-22.

Furedy, J. J., & Furedy, C. P. (1981). My first interest is interest: Berlyne as an exemplar of the curiosity drive. H. Day (Ed.) *Advances in Intrinsic Motivation and Aesthetics.* New York: Plenum Press.

Haywood, H. J. (19). Individual differences in motivational orientation: A trait approach. In H. Day, D. Berlyne, & D. Hunt (Eds.) *Intrinsic Motivation: A New Direction in Learning.* Toronto: Rinehart and Winston of Canada.

Henderson, B. B., & Gold, S. R. (1983). Intellectual styles: A comparison of factor structures in gifted and average children and adolescents. *Journal of Personality and Social Psychology,* 45(3), 624-632.

Henderson, B. B., & Wilson, S. E. (1991). Intelligence and curiosity in preschool children. *Journal of School Psychology,* 29, 167-175.

Kagan, J. (1972). Motives and development. *Journal of Personality and Social Psychology,* 22, 55-66.

Keller, J.M. (1979, Summer). Motivation and instructional design: A theoretical perspective. *Journal of I nstructional Development,* 2 (4), 26-34.

Keller, J.M. (1983). Motivational design of instruction. In C.M. Reigeluth (Ed.). *Instructional Design Theories and Models: An Overview of Their Current Status.* Hillsdale, NJ: Erlbaum.

Keller, J. M. (1987 November/December). The systematic process of motivational design. *Performance and Instruction,* 1-8.

Kerr , J., & Beer, J. (1992). Specific and diversive curiosity and depression in junior high school students of divorced and nondivorced parents. *Pyschological Reports,* 71, 227-231.

Langevin, R. (1971). Is curiosity a unitary construct? *Canadian Journal of Psychology,* 25, 4, 360-374.

Lanzetta, J. T. (1968). The motivational properties of uncertainty. In H. Day, D. Berlyne, & D. Hunt (Eds.) *Intrinsic Motivation: A New Direction in Learning.* Toronto: Rinehart and Winston of Canada.

Loewenstein, G. (1994). The psychology of curiosity: A review and reinterpretation. *Psychological Bulletin,* 116(1), 75-98.

Malone, T. W. (1981). Toward a theory of intrinsically motivating instruction. *Cognitive Science,* 4, 335-369.

Maw, W. & Maw, E., (1964). An Exploratory Study into the Measurement of Curiosity in Elementary School Children. Cooperative Research Project No. 801.

Maw, W. & Maw, E. (1965). Differences in preference for investigatory activities by school children who differ in curiosity level. Psychology in the Schools, 2, 263-266.

Maw, W. & Maw E., (1966). Children's curiosity and parental attitudes. *Journal of Marriage and the Family,* 28, 343-345.

Maw, W. & Maw, E. (1977). Nature and assessment of human curiosity. In P. McReynolds (Ed.), *Advances in Psychological Assessment,* 4, San Francisco: Jossey-Bass.

Naylor, F. D. (1981). A state-trait curiosity inventory. *Australian Psychologist,* 16(2), 172-183.

Olson, K. R., Camp, C. J., & Fuller, D. (1984). Curiosity and need for cognition. *Psychological Reports,* 54, 71-74.

Penney, R. K., & McCann, B. (1964). The children's reactive curiosity scale. *Psychological Reports,* 15, 323-334.

Porter, L. W. and Lawler, E. E. (1968). *Managerial Attitudes and Performance.* Homewood, IL: Dorsey Press.

Rezabek, R. H. (1994). Utilizing intrinsic motivation in the design of instruction. Paper presented at the Association for Educational Communciations (AECT) Conference, Nashville, Tennessee.

Rotto, L. (1994). *Curiosity, motivation, and "flow" in computer-based instruction.* Paper presented at the Annual Conference of the Association for Educational Communications and Technology, Nashville Tennessee.

Silverstein, A., Pearson, L., Dunnick B., & Ford, T. (1981). Psychometric properties of two measures of intrinsic motivation. *Perceptual and Motor Skills,* 53, 655-658.

Small, R. V. & Gluck, M. (October 1994). The relationship of motivational conditions to effective instructional attributes: A magnitude scaling approach. *Educational Technology,* 33-39.

Steers and Porter (1987). *Motivation and work behavior* (4th ed.). New York: McGraw-Hill Book Co.

Vidler, D. C., & Rawan, H. R. (1974). Construct validation of a scale of academic curiosity. *Psychological Reports,* 35, 263-266.

Vidler, D. C., & Rawan, H. R. (1975). Further validation of a scale of academic curiosity. *Psychological Reports,* 37, 115-118.

Yerkes, R. M. & Dodson, J. D. (1908). The relation of stimulus to rapidity of habit formation. *Journal of Comparative Neurological Psychology,* 1908, 18, 459-482.