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FACILITATING AQUATIC MOTOR DEVELOPMENT: A REVIEW OF DEVELOPMENTAL AND ENVIRONMENTAL VARIABLES

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ABSTRACT

Taking a developmental perspective, this paper reviews a number of important variables influencing aquatic skill acquisition including newly identified aquatic developmental sequences and several aquatic environmental factors. Developmental sequences for water entry, arm action, leg action, and body position have been hypothesized. Frequently overlooked environmental variables include depth, temperature, and humidity in addition to the more popular water clarity and chemistry factors. Another neglected factor in aquatics has been the role of large and small equipment in learning to swim. Equipment may successfully act to reduce fear in the young child. Finally, the learner-teacher interaction has been observed as an important factor in relation to the previous two variables. A conceptual model for teaching and research in aquatics is proposed to include these variables. A concerted developmental research effort is needed to bring aquatic practices in line with current educational and developmental theory and knowledge.

Throughout the twentieth century, national organizations such as the American National Red Cross (ARC) and the Young Men's Christian Association (YMCA) have provided leadership in swimming and aquatic programs in the United States (American Red Cross, 1968; Arnold & Freeman, 1972; deBabadillo & Murphy, 1973). These agency swimming programs have claimed remarkable success in reducing the rate of drowning in the population. The primary focus of these programs has been on teaching methods and behaviors. Recently, a spate of swimming texts have appeared with emphasis on the young child (Bory, 1971; Groscott, 1975; Miner, 1980; Murray, 1981; Newman, 1983; Prudden, 1974). These texts, too, have focused primarily on traditional teaching behaviors and activities. For the most part, both programs and texts have ignored the actual processes by which aquatic skills are acquired by the child.

This omission is not unique to aquatics, as Seefeldt has noted that many elementary physical education texts are "devoid of information to assist teachers in the analysis of the movements their programs are designed to elicit" (1980, pp. 314–315). Seefeldt also suggested that teachers of motor skills (presumably including aquatic specialists) need "1) a knowledge of developmental sequences . . . ; 2) the ability to identify the various levels of development . . . ; and 3) a knowledge of the activities and experiences that will assist the learner in moving to a mature level" (p. 318). The emphasis in swimming programs has focused on this third aspect of teaching. The two prerequisite teaching skills of knowledge and analysis largely have been ignored. This fact highlights the need to integrate aquatic programs and current motor development research literature. It also reinforces the call for further research addressing aquatic processes by young children (Langendorfer, 1986).

The purpose of this paper is to review current developmental aquatic research and to provide a pragmatic framework from within which further research could be conducted. Specifically, the paper will attend to hypothesized aquatic developmental sequences and to the identification of important environmental variables which may influence the acquisition of aquatic skills. A conceptual model for integrating various factors also will be proposed.

MOTOR SEQUENCES IN AQUATIC ASSESSMENT

There is ample evidence in the motor developmental literature that motor skills change over time, both in pattern and product scores (Roberton & Halverson, 1984). A number of studies have identified robust motor sequences for such skills as throwing (Roberton, 1977, 1978; Roberton & Langendorfer, 1980), striking (Harper & Struna, 1973; Langendorfer, 1987), hopping (Halverson & Williams, 1985; Roberton & Halverson, 1984), and rolling (Roberton & Halverson, 1984; Williams, 1980). There is evidence that aquatic skills progress similarly through ordered motor sequences (Erbaugh, 1978, 1980; Langendorfer, 1984a; McGraw, 1939; Oka, Okamoto, Yoshizawa, Tokuyama, & Kumamoto, 1978; Reid, Bruya, & Langendorfer, 1985).

McGraw (1935/1975, 1939) provided the first evidence for regular, ordered changes in infant aquatic behaviors. She demonstrated a shift from stereotypic "reflexive" swimming of the newborn to the "disorganized or struggling behavior" of the first year infant to the intentional or deliberate kicking and paddling motions of the older, water-experienced infant (McGraw, 1939). McGraw hypothesized that these aquatic changes reflected alterations in neural control structures. She claimed shifting neural control sites could be generalized to explain changes in other motor activities such as prone and erect locomotion, rolling, and sitting behaviors (McGraw, 1945/1963). Since she was not primarily interested in aquatic behavior, McGraw did not attempt to observe further changes in the intentional phase of swimming.

Recently, Erbaugh (1978, 1980) demonstrated sequential changes in intentional aquatic skills in preschool children. She developed an aquatic assessment instrument for preschoolers in which aquatic skills could be measured validly, reliably, and objectively (Erbaugh, 1978, 1980). Using this instrument, she noted a series of differences in aquatic motor patterns and accomplishments across age groups. For example, in the front locomotion category, the typical arm pattern of "inefficient paddling" action for the three-year-olds differed from the "efficient human stroke" and rudimentary attempts at "alternating overarm crawl" arm actions in five-year-olds. Similar kinds of differences were observed in other aquatic categories (Erbaugh, 1978, 1980).

Erbaugh (1981) subsequently observed longitudinal changes in aquatic movement patterns for young children between the ages of 3 and 5 years. In addition to changes in product scores such as distance able to be swum and amount of independence from teachers in water, she observed developmental changes in arm and leg patterns and body and head positions. Importantly, Erbaugh (1981) observed that some of these aquatic changes were sequential in nature. The young and less experienced three-year-olds predominantly moved through the water with a "leg-dominated" pattern while the older and more experienced five-year-olds used arm patterns, particularly with an "overarm crawl" pattern.

In a similar vein, a Japanese group (Oka et al., 1978) identified regular age-related shifts in the muscular organization and qualitative patterns of leg "kicking" motions as well as increased distance of locomotion across the preschool years. In particular, they noted a pattern shift from the "pedaling" swimming action of two-year-olds to a "flutter kick" action used predominantly by six-year-olds.

Langendorfer (1984a) has hypothesized changes in movement components (arm action, leg action, body position) for supine and prone aquatic locomotion. These observations appear remarkably consistent both with the Erbaugh and Japanese observations. The arm action sequence was hypothesized to shift from primitive rapid, short pulling motions to slower, but longer "action-reaction" paddling movements to an advanced aerodynamic "lift" or "sculling" action.

Similarly, leg actions were hypothesized to change from "plantar push" (i.e., pedaling) to "rapid dorsal splashing" to an advanced "efficient fluttering." Finally, he hypothesized decreases in horizontal body position angle in the water in both prone and supine locomotion actions.

Most recently, in a continuing longitudinal study, Reid and Bruya (1984; Reid, Bruya, & Langendorfer, 1985) proposed and then identified sequences in "entry to the water" skills. Categories in entry behaviors included movement pattern progressions, entry support progressions, equipment characteristics, starting positions, and degree of initial body part immersion. Frequency of occurrences based on 100 videotaped trials suggested that feet-first entries supported either directly by large equipment or teachers were the easiest methods for young children to use for initial entry into the aquatic environment. The data also suggested that the young children in the sample were more likely to enter after some body part was already wet or immersed in the water. The hypothesis from the data is that these frequently occurring behaviors are developmentally most primitive. Age and skill differences, however, have not yet been identified to confirm any developmental trends.

Research Directions for Assessing Aquatic Motor Sequences

Aquatic developmental sequences have begun to be identified, consistent with the urging of Seefeldt (1980). Unfortunately, these data have been acknowledged by few aquatic professionals and as such have not been included in current aquatic teaching or assessment techniques. Current aquatic assessment instruments (American Red Cross, 1968; Arnold & Freeman, 1971; deBarbadillo & Murphy, 1973) are traditional motor performance tests which emphasize product scores (e.g., length of breath holding; distance of prone glide). They also reflect the biases of the particular teaching techniques by representing specific teaching progressions rather than developmental changes in aquatic behavior. The developmental aquatic instruments which reflect developmental sequences and varying developmental levels (Erbaugh, 1978, 1980, 1981; Langendorfer, 1984a) need to be incorporated into the mainstream of aquatic assessment (Bruya, Franklin, Langendorfer, & Reid, 1984).

Seefeldt (1980) also suggested that activities and experiences used by teachers must provide developmental information to help swimmers move through the motor sequences. Current aquatic instruments and teaching techniques approach aquatic skill acquisition from an "error perspective" which does no fit with a developmental assessment perspective. The "error perspective" assumes that any behaviors not matching "mature" or biomechanically "correct" stroke patterns are "errors" and must be expunged by proper teaching. The problem with this perspective is that it ignores the existence of developmental sequences as well as age, readiness level, or current developmental status factors for each individual swimmer. The presence of motor sequences suggests that developmentally appropriate teaching techniques best individualize the expectations, activities, and drills by encouraging movement at developmental levels one beyond the current status exhibited by the individual (Roberton & Halverson, 1984; Seefeldt, 1980). Training programs for aquatic specialists must begin to emphasize observation and analysis skills oriented toward motor developmental changes (Reid, et al., 1985) as well as appreciation of cognitive and social developmental changes. Additionally, the identification of aquatic activities and equipment that provide challenges and opportunities for varying developmental solutions must be a major priority for aquatic specialists (Bruya, et al., 1984).

AQUATIC ENVIRONMENTAL VARIABLES

Children as well as adults come to the aquatic setting with a wide variety of personal aquatic histories. They may react positively based on successful experiences or, as a result of negative or insufficient experiences, they may show fear and trepidation. It is the contention of many experts (Ammons, 1984; Bruya, 1985b; Hutt, 1976; Shaw, 1976) that positive initial experiences promote superior learning and development. Likewise, the first aquatic experiences must be both gentle and happy as well as challenging and exciting. Such a positive impression most often is the responsibility of the supervising and care-giving adults. They also must be carefully planned prior to water entry. The likelihood of a positive experience is enhanced by careful selection of the major factors within the aquatic movement environment (Herkowitz, 1980; Seefeldt, 1980).

The major aquatic environmental factors identified in this review include water condition, facility design and large equipment structures, small manipulable equipment, and the child-adult (learner-teacher) interaction. Each of these factors will be reviewed and examined in relationship to their roles in aquatic skill acquisition. Several research directions for each also will be identified.

Variable 1. Water Condition

Physical water condition is the first major aquatic environmental factor considered here which may contribute to initial and lasting impressions on young children. Basically, four distinct water condition variables may affect young children's swimming: 1) water clarity; 2) water chemistry; 3) air/water temperature and humidity; and 4) water depth. The first three have received the most previous attention. In particular, water clarity and chemistry generally are subject to public health guidelines and have been discussed extensively in the literature (Thomas, 1972, 1976). Aside from unsanitary and poorly controlled pools and swimming areas which may deter reluctant participants, water clarity and chemistry probably have little immediate impact upon the acquisition of swimming skills (Langendorfer, 1986).

On the other hand, the temperature/humidity of the water and air has been a topic of continuing debate by preschool swimming personnel (Council for National Cooperation in Aquatics, 1985; Langendorfer, 1986; Langendorfer & Willing, 1985; Newman, 1983; Thomas, 1972). It may be a singularly important factor in the young child's adjustment to the water. Frequently, pools are multiuse facilities trying to accommodate the activity of numerous groups. A typical water temperature of 78–80°F (25°C) is comfortable for exercising adults but deviates drastically from the recommendations for children by most aquatic experts. For instance, the CNCA (1985) recommends a minimum of 82°F while various authors suggest minimums varying from 86° to 96°F (Murray, 1981; Newman, 1983; Thomas, 1976). Authors have reported particularly difficulty in teaching young children swimming and readiness skills at temperatures below 80°F (Newman, 1983; Timmermans, 1975). The immature thermoregulatory system of young children probably makes water temperature variations especially crucial for very young children and infants. There is even evidence that cool water may be a contributing factor in two reported cases of hyponatremia, or "water intoxication" in infants (Council for National Cooperation in Aquatics, 1985; Langendorfer, 1984b, 1985, 1986).

Equally important to water temperature is the relationship of air temperature to water temperature and the resulting relative humidity. Thomas (1976) recommends that air temperatures be maintained either 3–5°F higher than water temperatures or 85–87°F if the water temperature is 85°F or higher. He also recommends relative humidity between 75–85%. The resulting balance between air and water temperature in a pool environment creates high humidity which reduces water evaporation from the skin, reducing the chilling effect. In fact, one of the authors has noted that a temporary air temperature increase 5°F above water temperature to 87°F during the period of lessons has reduced complaints by instructors, young children, and the handicapped swimmers in one aquatic program.

One often neglected factor in acquisition of aquatic skills by young children is the depth of water in which the learning must occur. Like water and air temperature, pool depth usually is determined by the needs of adult users and is not adjustable for young swimmers. The availability of relatively shallow water becomes particularly important for the young nonswimmer since these same individuals are just beginning to master balance in a terrestrial environment. Lack of foot support and balance in a cool, viscous, buoyant medium like water can be a terror-evoking experience to the young child. The experience of many preschool swimming authors has suggested the importance of independence of movement in actually learning to swim (Arnold & Freeman, 1971; deBarbadillo & Murphy, 1973; Langendorfer, 1984a). In fact, Australian swimming instructors have noted the ease with which young children teach themselves to swim when they are in water in which they can stand (Bory, 1971; Timmermans, 1975). The next section will discuss means for artificially varying the water depth for young children.

Research Directions in Water Condition Factors

The controversy regarding water conditions largely is based upon varying opinions by many self-designated experts. Remarkably, little empirical research has been conducted regarding the effect of the water condition variables such as temperature and depth. A number of the concerns could readily be addressed and answered with simple research studies. For instance, the claim that water temperature contributes to hypothermia and other diseases could be decided simply by measuring body temperature changes resulting from swimming lessons in several different pool and air temperatures. Comparisons of changes in swimming skills for groups taught in deep and shallow pools also is a readily accomplishable study. The failure of swimming personnel to conduct relatively simple research studies of this nature before issuing opinions has perpetuated a number of myths and misunderstandings (Langendorfer, 1986).

Ongoing studies related to the effects of water variables on health and safety as well as skill acquisition of young children are needed drastically. The aquatic community needs to understand the effect of water and air temperatures and water depth upon young children trying to learn to swim. The studies are, by nature, developmental since many of the effects likely are related to age, body size (Erbaugh, 1986b), skill level, developmental status, or experience (Erbaugh, 1986a). A forum for the investigation, discussion, and dissemination of recent findings is being developed by the Council for National Cooperation in Aquatics through the newly published *National Aquatics Journal* and the National Advisory Committee on Aquatics for Young Children. This is a necessary and important first step.

Variable 2. Small Equipment in the Aquatic Environment

It can be noted that swimming instructors frequently use a variety of toys and small equipment as an aid in teaching swimming and aquatic play with young children in the water. For the purpose of this review, small equipment will be divided into three general categories: 1) flotation and body support; 2) aids to locomotion; and 3) toys and distractors. The first type of equipment includes the standard kickboard, pull buoy, inflatable arm cuffs, inner tubes, styrofoam "bubbles," and lifejackets or PFDs (personal flotation devices). Recently, several inflatable vests and swimming suits with foam inserts have appeared on the market which also fall into this category. Equipment in this category has been popular in many preschool swimming programs (deBarbadillo & Murphy, 1973). The efficacy of such equipment has been noted by Erbaugh (1986a) when the mean ages for acquisition of supported and unsupported children's swimming locomotion skill differed significantly.

The second type of small equipment overlaps the first category to the degree that flotation devices also aid locomotion specifically and other swimming skills generally (Erbaugh, 1981, 1986a). Items specific to the locomotion aid category include fins (also called "flippers"), hand paddles, and masks or goggles. Although these items are less frequently used for teaching young children, they have been suggested for older swimmers (American Red Cross, 1968; Arnold & Freeman, 1972).

Finally, a variety of other toys and aquatic equipment, both commercially available and homemade, often are observed in the young child's aquatic environment. For example, boats, balls, rings, poker chips, washclothes, watering cans, and submersible painted objects are a few of the suggested aquatic play items (Murray, 1981; Newman, 1983). Erbaugh (1987) described that in water play situations "toy-mediated play" was most commonly observed as compared to conventional (i.e., games) or physical play (i.e., parental contact, splashing, or roughhousing). It could be hypothesized that, in addition to flotation supports, aquatic toys and small equipment have some inherent motivating characteristics for young children that allow them to serve as distractors for the fearful or reluctant young child. Their relative familiarity in an otherwise unfamiliar environment also may contribute to their value and frequency of use.

Research Directions for Small Aquatic Equipment

Small aquatic equipment use may represent a significant variable in aquatic skill acquisition for young children, either as incentives and motivators or as physical supports to movement. At the present time, however, the use of small equipment in aquatics can be described more as an "art" by creative instructors than as a scientifically based teaching technique. The exploration of small equipment is an area ripe for empirical investigation.

A task analysis approach (Herkowitz, 1980, 1984; Morris, 1976) may provide one fruitful framework for investigation of small equipment. For instance, one "factor" from an aquatic task analysis for children learning to swim may include "types of support" with levels of complexity ranging from 1) no flotation device to 2) support by an adult to 3) support with a styrofoam "bubble" to 4) support from inflatable arm cuffs. Differences in learning time (number of lessons to criterion) could provide an empirical test for significant differences between types of support. Further testing for interactions between age, skill, or amount of experience by support type could illustrate important developmental trends or differences that could have very practical applications. In addition, different sizes and types of equipment could be compared for shifts in developmental patterns or rates of change (Erbaugh, 1986a; Reid et al., 1985).

Variable 3. Facilities and Large Equipment

Until recently the design of aquatic facilities and the use of large play equipment for promoting skill acquisition has been largely neglected in the aquatic literature. The development of a body of literature for the use of large contemporary play equipment in children's play environments has lead to explorations of play equipment in aquatic environments (Bowers, 1976; Bruya, 1985a, 1985b; Bruya & Buchanan, 1977, 1978; Fowler & Bruya, 1983; Hutt, 1976).

Findings in support of the value of contemporary play structures have recently been reported. First of all, it is reported that play structures actually magnify children's feelings of competence due to the number of choice and options available (Shaw, 1976). Events (i.e., individual parts of play structures) can provide children incentives for moving through the structure (Carter, Bruya, & Fowler, 1983; Fowler & Bruya, 1983). An accessible structure design also encourages use by children of varying ages and skill levels (see Table 1.). The concept of "linkage" promotes a unifying concept for diverse play structures and events placed in proximity to one another. Such a "linked" structure provides more complexity and play options than each of the individual events (Bruya, 1985b; Shaw, 1976). Additionally, the numerous options offered by contemporary play equipment for movement at varying developmental levels permits the child to approach the structure in unique ways as his/her perceptions change due to growth and experiences with the structure (Bruya, 1979; Bruya & Buchanan, 1977). Thus, play equipment seems to motivate children by providing incentives such as hierarchic motoric options and feelings of competence due to familiarity in the surroundings (Bruya & Buchanan, 1977, 1978).

As these design elements and resulting benefits to children's play were iden-

Table 1
Play Structure Design Elements for Use in the Aquatics Medium

DESIGN ELEMENTS FOR AQUATIC STRUCTURES*	
Linkage	Individual parts attached to create a larger single structure
Play Routes	Preferred directions that children follow when using the structure
Events	Those parts of the structure that attract and hold a child's attention and encourage movement

*Adapted from Bruya, 1985a

tified, it was suggested that they might be applied equally to aquatic play (Bruya, 1985b; Franklin & Bruya, 1983; Franklin, Bruya, & McWilliams, 1984). Hutt's investigation (1976) revealing that nursery school children spent more time investigating and playing with novel objects (i.e., equipment) suggested that large equipment in the water could present a similar type of "familiar novelty" which both would encourage and challenge young children to explore it (Bruya, 1985b; Reid & Bruya, 1984). In fact, Reid & Bruya (1984) verified that young children placed in an aquatic environment with complex configurations of equipment did indeed spend time slowly adapting to the water and acquiring rudimentary aquatic skills at an individualized pace. In addition, the presence of large equipment encouraged perserverance in practicing skills while decreasing negative behaviors such as crying and reluctance to participate (Reid et al., 1985).

Research Directions: Large Aquatic Equipment

The research studies dealing with large equipment in the aquatic environment have been limited in number and scope. While the initial findings have supported the positive value of aquatic play equipment, studies have been limited to preschool children receiving beginning experiences with the water. There is a need to explore age, skill, and gender differences in children's use of play structures. It is certainly unknown to what extent play structures can promote aquatic learning for older and more experienced swimmers. In addition, specific teaching techniques for individual pieces of equipment, for different equipment configurations, and for varied "linkage" designs must be studied. Integrating play structures with traditional "learn-to-swim" techniques and goals also will be needed.

Variable 4. Student-Teacher Interactions

The acquisition of swimming skills traditionally has been assumed to be a product of an instructor's intervention (ARC, 1968; Arnold & Freeman, 1972). Under this assumption, the aquatic learning process was seen to result primarily from efficient and appropriate instruction and feedback from a teacher. In addition, many persons assume an "error perspective," (i.e., that learning is a gradual process of eliminating improper movements) to be a fact. All too frequently the traditional methods of aquatic instruction have failed to acknowledge the existence of individual differences in learning rates, styles, and performances. In addition, the traditional aquatic instructor has little familiarity with the concepts of the active nature of learning and developmental processes, the existence of developmental sequences of changes, and pedagogical and learning principles from human movement, sport, and exercise.

Previous information in this review has suggested the existence of new perspectives for viewing aquatic skill acquisition. Specifically, developmental

changes in aquatic skills as described by different investigators have been reported. Such regular, sequential, and gradual changes in aquatic motor skills differs appreciably from the traditional behavioristic and teacher-oriented perspectives. In addition, a number of previously neglected environmental variables such as water conditions and small and large equipment have been noted as important parts of the aquatic skill acquisition process.

Concomitant with these novel and differing perspectives on the aquatic learning process are some incumbent changes in student-teacher interaction styles. The previous information suggests that the emphasis in aquatics should be shifted from instruction by the teacher to learning by the child; from eliminating "errors" to eliciting developmentally more advanced behaviors and motor patterns; and from traditional teaching methods to play-leader guided discovery and exploration (Mossten, 1966).

Even fairly traditional pedagogical information suggests that varied teaching styles provide important considerations in the instructional setting (Mossten, 1966). In that light, it may be more appropriate for the teacher of young children to use an exploration or guided discovery style instead of the more common command style. As an example, problems may be proposed to children in relation to pieces of equipment (e.g., Can you duck under the kickboard? or Can you float on your back while holding the float on your chest?). Also, attention to major factors in aquatic environmental engineering may be an important addition to teaching swimming to young children (Herkowitz, 1980, 1984). Controlling such aspects as water depth or temperature, the use of flotation devices, or large play equipment all may be very important when structuring the aquatic learning environment. Erbaugh (1987) observed the frequency of toy-mediated play between parents and children. Apparently, as observed earlier in this paper, toys can serve important motivational roles in aquatic skill acquisition.

Research Directions: Student-Teacher Interactions

The whole relationship between aquatic instructor and student needs to be reevaluated in light of these attempts to ". . . make the content fit the needs of the children rather than making the children fit the progression" (Logsdon, 1984, p. 294). This presupposes that the aquatic instructor is willing to permit the students to ". . . create something and not . . . do something that has been predetermined" (Ammons, 1984, p. 455). Research in teacher behavior particularly from the movement education perspective (Barrett, 1984) will lead to important new directions in aquatic instructional techniques. These changes in pedagogical orientation also may lead to changes in the ultimate goal of aquatic education. Perhaps the primary purpose for aquatic instruction must change from learning swimming strokes to acquiring overall competence in "watermanship." Instructors will learn to accept and, indeed, encourage aquatic movement outcomes beyond traditional strokes and skills.

There is a need to develop new aquatic teaching curricula including problem statements and movement progressions that both structure and encourage aquatic learning. Learning progressions for enhancing entry skills, prone and supine locomotion skills, breath control, and advanced water safety skills must be developed and pilot tested. From a developmental perspective, such progressions must be examined for their utility with different age and skill levels. From a play perspective, new schemes and role models for aquatic play leaders must be introduced. Finally, teaching and interaction patterns for use with large and small equipment and from an environmental engineering perspective must be introduced to aquatic education.

A MODEL FOR AQUATIC SKILL ACQUISITION

The previous review has suggested the need for different ways of conceptualizing aquatic skill acquisition. Figure 1 presents a proposed "model" of one possible configuration of factors in aquatic education. The model suggests three levels of "independent" factors leading up to "outcome" or "dependent" factors. As suggested previously in this paper, an assessment of the learner's past history of experiences, motivation, and predisposition to the water plus the present status of aquatic movement patterns and skills provides a basis for subsequent instruction planning. In terms of instructional planning, the model suggests both "environmental" and "teaching" factors as the basis for teaching preparation. The manipulation of water conditions, use of small and large equipment, novel games, and activities constitute the major factors which the aquatic instructor must consider when setting or engineering the aquatic environment for each student. Obviously, typical class settings must include large numbers and varieties of such variables in order to accommodate expected individual differences. The final level of intervention factors in the model includes attention to teaching techniques and understanding of developmental needs. Finally, outcome factors are diversified to include a number of different possible levels and goals of aquatic learning. For instance, not only does aquatic learning lead to strokes, but also to "readiness" skills such as breath control and water entry and "watermanship" skills such as water safety, lifesaving, and advanced skills.

While the model is proposed as a pragmatic instructional device for aiding instructors in structuring the aquatic learning-teaching environment, it also can serve as a tool for planning basic aquatic research. We suggest that the factors at any level of the model can serve as either independent or dependent variables within a research study. For instance, a researcher might measure some level of learner history such as fear of the water (assessment factor) and determine the effect of that factor upon the rate or extent of eventual aquatic skill acquisition. In an empirical vein, a researcher might provide an intervention strategy to lessen

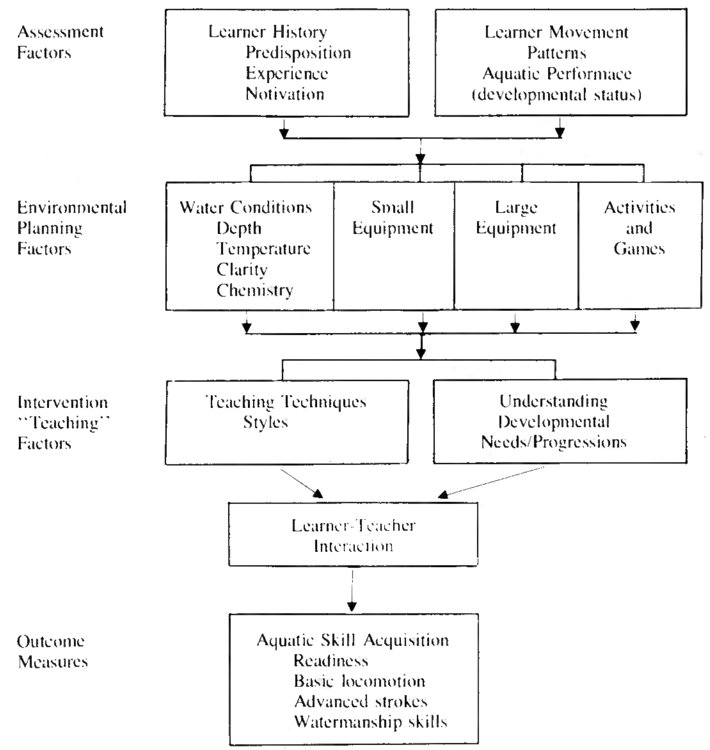

FIG. 1. A proposed model for classifying major factors in the acquisition of aquatic motor skills

fear and determine the correlational effects on improvement in skill acquisition. In addition, the researcher-teacher may be interested in modifying a planning factor such as water temperature or the presence of large equipment and subsequently determine whether fear continues to be displayed. Similar studies can and should be developed at all factor levels within the model in order to solidify our understanding the aquatic skill acquisition process.

The goal of this review paper perhaps can best be summarized by the following quote from Kate Barrett (1984) in her description of the purpose for creating an environment for learning movement:

> A commitment to helping all children reach their potential for movement is a commitment to creating an environment that optimizes learning. Children cannot learn how to move unless this occurs. For this to happen children must be
>
> safe,
> on task successfully,
> challenged,

and confident.

(Barrett, 1984, p. 347)

The purpose of this paper has been to promote a similar goal in aquatic environments: safe, successful, challenging, and developmentally appropriate activities, equipment, and teaching techniques to promote optimal aquatic skill acquisition.

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