AQUA 101: Principles of Water

Here is a summary of what you are about to learn:

Laws of Motion: Sir Isaac Newton

- An object in motion will stay in motion (same with rest)
- Action/ Reaction: for every action there is an equal and opposite reaction
- Force X Speed = Acceleration
    - Force is employed when a muscle contracts
    - Speed is the pace of movement in the water
        *Water speed is half of land speed

Water Principles:

- Buoyancy: Upward force in the water, reduces shock impact
- Drag: Also known as water resistance is twelve times that of air
- Viscosity: Property that makes water resistant based on adhesion and cohesion
- Turbulence (Whirlpool or Eddy): The amount of water disturbed by the exerciser's movement
- Surface Space: Surface area the body creates in the disruption of the water
- Surface Tension: Like a membrane on top
- Heat Dissipation: The ability to cool the body by releasing heat into water cooler than body temperature

Educational Installment: Principles of Water

1. Foundation of Water Movement

An instructor must possess a solid understanding of water principles in order to design appropriate aquatic movement to be used in various water fitness class designs. WATERinMOTION® introduces the instructor to Newton's Laws of Motion and water principles, while exploring how each of these concepts impact water exercise.

2. Sir Isaac Newton's Law of Motion:

An object at rest remains at rest, an object in motion stays in motions, unless acted upon by an outside force. When discussing water fitness, the participant's muscular contractions are considered the force that affects movement. In order to move in the water, energy is required to fuel muscular contractions. Once the body is moving in the water, it requires an additional application of force to overcome momentum and stop movement, change the type of movement, or change direction.

Instructors should be aware of two types of physical movement: (1) movement within the body (moving joints, i.e., jumping jack) and (2) movement of the body (moving through space from point A to point B, i.e., jogging while traveling forward). Both types of movement require energy, muscular contraction and force. The force used for movement causes other reactions in the body, such as increased heart rate, and other reactions in the environment, such as increased water turbulence.

3. Newton's Law ofAction/Reaction:

Every action creates an equal and opposite reaction. Newton's Law of Action/Reaction is important when determining how difficult a movement will feel to a participant in a water fitness class. To illustrate this law, examine the execution of a front kick while standing in chest deep water. The participant would flex at the hip joint to move a straight leg in front of his/her body. Two obvious reactions would occur: (1) The water around the leg would move upward and forward, conversely (2) the participant's body would have a tendency to move downward and backward. Experimenting and understanding the various natural reactions that occur in water when executing body movement will help you design appropriate exercises for your clients. When you choose movements that allow your body to work with the natural reactions between body and water, the movement will feel intuitive and cause less resistance/effort (easier movements, recovery movements). On the other hand, when you design movements that oppose the natural reactions, you can offer challenges in resistance, as well as balance (harder movements).

4. Force x Speed =Acceleration

The speed at which a participant moves is multiplied by the amount of force used to perform the movement. Acceleration can be increased with faster and/or stronger movements. Moving faster during exercise may not necessarily be the best choice for increasing acceleration in a variety of situations. Speed may also bring a risk of injury. Moving faster can encourage the use of momentum instead of muscular control. This defeats the purpose of exercise for health and fitness improvement. In the water, participants have the ability to manipulate acceleration by pushing off the bottom of the pool and against the water itself instead of moving faster. Motivating students to use forceful movement in the water may be the most difficult part of class instruction. Describing what forceful movement feels like to the body may help students to feel comfortable with the body's ability to use force. Creative cueing and educating participants of the water's unique ability to allow this increased application of force without unnecessary risk will also help participants discover the potential of water fitness.

5. Buoyancy

Any object, wholly or partly immersed in a fluid, is buoyed up by a force equal to the weight of the fluid displaced by the object. Buoyancy, as applied to water fitness, can be explained easily: participants will have a tendency to experience a partial floating feeling when exercising in a pool. Buoyancy makes water exercise less jarring to the joints of the body by reducing impact shock. It also reduces the weight on the body's joints as it allows less restricted, full range of motion movement. This opens water fitness to a variety of populations.

Buoyancy significantly alters traditional land type movements when the same movements are performed in the water. This is due to the decrease in gravity encountered in the pool versus the land. Because we are not anchored to the pool bottom like we are anchored to the floor when on land due to gravity, you will need to change the way you perform and/or cue the same movement when transitioned into the water. For example, a grapevine can be performed easily on land but requires modification (slower tempo and rebounding) to be executed in the pool.
Another example could be a march. On land it is intuitive to emphasize the movement of the foot down in each march step, but in the pool it's more

natural to focus on the lift of the knee while rebounding. For shallow water exercisers, movements performed when rebounding become more intuitive than executing the same move while staying grounded to the pool bottom. Rebounding is defined as any movement that involves pushing off of the bottom of the pool in a jumping fashion. Rebounding creates a temporary increase in gravity, which aids the exerciser in touching the bottom of the pool.

Buoyancy will also affect participants differently depending on the ratio of lean muscle mass to body fat the participant possesses. Keep in mind that dense material, such as muscle, will have a tendency to sink. In the water environment, participants with a low body fat percentage (more muscle mass) will be less buoyant causing them to sink and those with higher body fat will be more buoyant causing them to float. The buoyancy principle will affect how exercisers are able to move in the water. When designing movement for a group setting, keep this information in mind to accommodate all participants and provide an effective workout. Cue participants with a higher percentage of body fat to pay close attention to overall posture since their distribution of fat stores may destabilize them during aquatic exercise. Also, instruct them to position themselves at a water depth even with their chest level. Deeper water will further destabilize them because of increased buoyancy. Participants with a lower percentage of body fat will be challenged to perform suspension moves since muscle is denser than fat and will make them sink. Any movement that is assisted by buoyancy will be more challenging for a muscularly dense participant.

6. Drag: Water Resistance

Water offers 12 times the resistance of air because water is denser than air. The amount of drag experienced in water is determined by the size, shape and material of the object moving through the water, the viscosity of water, and the speed at which the object moves. It takes more muscular effort to push against the water and lift your leg in the pool than on land against the air. If you put a swim fin on and execute the same leg lift, it becomes even harder due to the increase in the size of the object that is moving against the water's resistance. Therefore, it is important to keep in mind that class segments targeted to be moderate in intensity should be designed with movements that create less water resistance (like a jog or hamstring curl) as opposed to creating highly intense segments in which you would choose to use movements that create more water resistance (like a cross country or straight kick).

7. Viscosity

Viscosity is the property of a fluid that tends to prevent it from flowing when subjected to an applied force, or a measure of a fluid's resistance to flow, occurs due to water molecules' tendency to stick together (cohesion) and water molecules' tendency to stick to anything submerged in it (adhesion). When a participant enters the pool, water adheres to the surface of the participant's body. The water molecules that are sticking to the participant are also trying to stick to other water molecules. As the participant moves through the water, he/she “drags” the water molecules that are stuck to his/her body as well as the water molecules that are attempting to stick to each other. This is what causes the resistance you feel when working against the water.

Initially, overcoming water resistance is challenging, but the drag will eventually decrease and resistance will be minimized once momentum is created with the continued movement of the participant and the continuously moving water. If making exercise or movements easier is not your plan, you may choose to continue opposing the drag by making participants change directions, using long lever movement, increasing force, adding traveling and/or increasing surface area to work against the viscosity.

Using the water's property of drag can lead to the creation of whirlpools or eddies, as well as turbulence. The more turbulence a participant creates through movement, the more challenging the workout becomes. In order to increase the intensity of water exercise every effort is made to increase surface space and use non-efficient physical movements. In other words, it is important to create movement patterns that utilize large amounts of space

and those that create turbulence (a chaotic behavior of the fluid, characterized by fast variations of the fluid's velocity, both in space and time by moving large volumes of water).

Swirling patterns that participants create in water fitness classes are a perfect example of a movement pattern that creates turbulence. This chaotic water pattern makes moving in the water even more challenging because the body continually experiences changes in the water's resistance. At times it assists movement and at times it resists movement. To maintain a desired upright posture and balance in the water, participants will continually adjust to the forces of turbulence. Using forceful movements will overcome this whirlpool effect and aid students in controlling their bodies during exercise.

Changes in surface area will affect how challenging a movement becomes and the amount of turbulence that can be created in the water. The larger the surface area that is moved through the water, the more force that will be necessary to perform that movement. For example, a golf club would be easier to move through the water than a tennis racquet. Closely related to surface area is lever length. A lever could be an arm, leg, or maybe even the whole torso combined with the legs. The longer a lever, the more effort it takes to move it through water resistance.

8. Surface Tension

Surface tension is the water resistance at the water's surface. This is another property of water that will affect movement choice and class design in water fitness. The cohesiveness between water molecules is responsible for creating surface tension. The surface water molecules are not surrounded by other water molecules on all sides and consequently are more cohesive than those under the water's surface. The cohesiveness forms a surface "membrane" making it more difficult to move an object through the surface than when the object is completely
In water exercise, surface tension is a concern when directing students to move the arms out of the water to shoulder level or higher. To avoid risk of injury to the shoulder joint, guide participants to first decrease lever length and surface space of the arms before moving the arms either out of the water or back into the water. It is perfectly safe to incorporate out of the water arm movements into movement design for the purpose of increasing movement intensity, core muscle recruitment and creativity as long as you keep in mind that the exit from and entry back into the water requires short levers and decreased surface space.

9. Heat Dissipation: The process of becoming cooler

Water can provide the perfect place to exercise and stay cool at the same time; a primary benefit of water fitness for participants. This is possible because heat dissipation is increased while exercising in water that has a lower temperature than the participant's body temperature.

In land based exercise settings, as the exercise intensity increases, the participant's core body temperature increases as well. For some exercisers, the increase in intensity may be appropriate but the increase in core body temperature may not. For example, a pregnant participant should take care to regulate her core body temperature to avoid dizziness and possible harm to the fetus. Other medical conditions could also limit a participant's tolerance for any increase in body temperature, like hypertension and menopause.

Because water has the ability to absorb heat from submerged bodies quickly (heat dissipation), a participant may increase exercise intensity without necessarily experiencing the usual increase in core temperature. Keep in mind that water below 78°F may not be appropriate for water fitness classes. Most students will be cold and unable to maintain a comfortable body temperature even with rigorous movement. Pool temperatures above 88°F may be perceived as very warm to some students. If participants are feeling hot and the pool temperature is high, an instructor may choose to alter the class design and avoid intense aerobic movement. SCW Fitness Education's Aquatic Fundamentals Certification recommends general water temperature between 80 and 86 degrees for most class types.

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