

Drop, Stop, Pop: Keys to Vertical Jumping

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Vertical jumping is a fundamental motor skill which emerges in its most rudimentary form before the age of three (Wickstrom, 1983). Vertical jumping is also an important component of many complex activities such as volleyball, basketball, baseball, football, soccer, track and field, diving, gymnastics, and modern and classical dance. Consequently, vertical jumping is taught across a wide range of grade levels and in a variety of places in the physical education curriculum. Given that most young adults, even those who compete in jumping activities, have not reached their potential in jumping (Hudson, 1986), it seems reasonable that jumping should be included more often in the curriculum.

What are the keys to jumping skillfully? Over the past several years, my colleagues and I have conducted a number of research studies of jumping. Although some of the methods and technologies we have used are not suitable for the typical school environment, our ultimate intention has been to identify characteristics of skillful jumping that are observable by teachers and coaches as well as manipulable by performers. Even though we are still asking and answering questions, some of our results and insights may be helpful to physical educators. What follows is an illustrated overview of vertical jumping, a brief summary of our research into jumping, a prioritized list of

keys to jumping skillfully, a few simple tools of observation, and some suggestions for drill and practice.

Overview of Vertical Jumping

The vertical jump can be performed with or without an arm swing. In fact, the arm swing can contribute minimally to the jump as in heading a soccer ball, moderately as in rebounding a basketball, and maximally as in spiking a volleyball. However, regardless of the style of the arm swing, the legs and trunk perform similar actions in most types of jumps. To emphasize the action of the legs and trunk, Figures 1-5 show a jump taken with the hands on the hips.

Before the jump starts (Figure 1), the trunk and legs are relatively extended. The jump begins with a drop (Figure 2): the leg muscles relax, the body moves rapidly downward, and flexion at the hips, knees, and ankles occurs. The drop ends with a stop (Figure 3): through a vigorous contraction of the muscles, the downward movement is braked and the body pauses briefly in a crouched or flexed position. Next is the pop (Figure 4): the muscles of the legs and lower back contract vigorously to cause extension so that the body moves upward and eventually into flight (Figure 5).

What Research Tells Us About Jumping

When we conduct research on jumping, we film jumpers with a high-speed camera which takes 100 pictures a second. Then, we project these pictures onto a digitizing tablet which allows us to measure locations on the body very precisely. Finally, we use a computer to make several calculations. A comprehensive discussion of these methods can be found in an article entitled "Coordination of segments in the vertical jump" (Hudson, 1986).

We have used this technology to compare very skilled jumpers with those who are less skilled. From this research we have concluded that the best jumpers take a rather small drop. That is, during the drop, their hips move downward about 10 inches compared to about 14 inches in less skilled jumpers. Also, the best jumpers have a very abrupt stop. In other words, the transition from moving downward to moving upward occurs almost instantaneously: the trunk, thighs, and lower legs stop moving downward at almost precisely the same time. Then, immediately, the trunk, thighs, and lower legs start moving upward at virtually the same time. As for the pop, better jumpers are very quick. Because they can go from the stop to take-off in about one fifth of a second, they appear

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to "pop" off the ground. Less skilled jumpers need about one third of a second for the pop. Thus, very successful jumpers are separated from mediocre jumpers by about one tenth of second. No wonder we have so much trouble helping people jump well!

If you have access to a video camera and tape deck equipped with stop action, you can repeat these experiments with your students. By making an overhead transparency from a sheet of graph paper, you can take tracings of movement from a television screen. To assess the quality of a jump, you will need to mark the top of the head, the hip point (i.e., the intersection of the trunk and thighs), and the bottom of the feet in a picture like Figure 1. Also, mark the hip point at the stop position (Figure 3) and at the top of the jump (Figure 5). It might be helpful for locating the hip point to take the second tracing (Figure 3), first. To calculate the depth of the drop, measure the difference in graph paper units between the hip point in Figure 1 and Figure 3; then, divide this distance by the standing height (i.e., the difference between the top of the head and the bottom of the feet in Figure 1). Better jumpers generally score about .15 and poorer jumpers about .20.

You can assess the quality of the stop by noting the picture or frame when the first body part stops moving downward (i.e., trunk, thighs, or lower legs) and by counting frames until all body parts are moving upward. A gap of more than two frames is too long for a very skillful jump. The quickness of the pop can be measured by counting frames from the one in which the first body part (i.e., trunk, thighs, or lower legs) starts moving upward until the frame when the feet are clearly off the ground. A pop which takes only seven or eight frames is indicative of a very good jumper.

Finally, improvement can be measured from one month to another by comparing the ratio of height of jump to height of body. That is, subtract the hip point in Figure 1 from the hip point in Figure 5; then, divide this number by the standing height. Since measuring the drop, stop, and pop with these methods can be time-consuming, you may wish to solicit help

from science teachers, other students, or parents. In addition, improvement in jumping height can be measured with less time-consuming, standard tests such as the jump and reach.

Keys to Jumping Skillfully

Regardless of how one measures improvement, it is difficult to produce better jumps without knowing the keys to jumping skillfully. In the progression from first jumps as a three-year-old to optimal jumps as a competitor, there are five characteristics of skillful jumping which must be incorporated.



Figure 1. Start.

Initially, young jumpers are hesitant to use all of their body parts vigorously. For example, the trunk may not be very involved in the jump. The first key to jumping is to get all the appropriate body parts, including the trunk, thighs, lower legs, and arms, moving vigorously.

Once a jumper is making vigorous use of all body parts, there will be a tendency to be out of balance. The landing spot may be distant from the starting spot. Or, the stop and pop may be altered in response to an off-balance drop. Thus, the second key to jumping is to maintain proper balance throughout the jump.

After a jumper gains confidence in not losing balance, exploration of range of motion can begin. Many people believe that a deep drop is essential to a skillful jump. Consequently, a high proportion of experienced jumpers remain at this stage of skillfulness. Of course, a person cannot jump at all without a drop through some range of motion, but a shallower rather than a deeper drop is the third key to skillful jumping.

A jumper who takes a deep drop requires more time to jump. However, a jumper who takes a shallow drop has the option of being either slow or fast in the pop. Learning to perform a quick pop is the fourth key to skillful jumping.

A jumper is most apt to get an abrupt stop by dropping through a shorter distance and by vigorously contracting the muscles to achieve a quick pop. This translates to a nearly simultaneous and instantaneous coordination of segments from the drop to the pop. If the arms are involved in the jump, they should begin moving upward and/or ahead of the body at the same instant that the rest of the body starts the pop. Thus, simultaneous coordination of segments is the fifth, and final, key to skillful jumping.



Figure 2. Drop.

Almost all people achieve the first key to jumping and many achieve the second; less and less achieve the third and fourth keys and only a few achieve the fifth. With a lot of practice and progressive instruction through the keys, many more students will be able to execute the ultimate, well-coordinated jump.

Tools of Observation

How do you know which of the keys to focus on? How do you know what to look for? A jumper at the first stage will appear to be hesitant or restricted in movement. To move beyond this stage, the jumper needs to look confident and show vigor.

Early in the second stage, jumpers will be so vigorous that they appear to be off balance. It is easy to classify the jumper who seems to be on the edge of disaster. As a jumper improves in balance, it becomes more difficult to notice the subtleties of poor balance. However, a person who has mastered balance should be able to jump vertically rather than obliquely when asked. It may be helpful to use markings on the floor as a guideline. For example, if a jumper started with the toes at the edge of the sideline and then



Figure 3. Stop.

jumped as high as possible, the toes should be within an inch or so of that edge at landing.

The depth of the drop is important to observe. One strategy is to take a mental snapshot of the body when it reaches the stop position: the knees should not be flexed beyond a right angle. Another strategy is to watch the top of the head against a background with horizontal lines such as a brick wall. The difference between the standing position and the stop position should be about a foot.

Without a video or film camera, speed of movement is difficult to assess. How-



Figure 4. Pop.

ever, one can make comparative judgments by having two adjacent people jump at the same time. Although many spectators think that they can tell coordinated from uncoordinated movement, the refinement in coordination which is necessary for optimal jumping may be unobservable without a camera.

Is it good news or bad news that the problems of most jumpers can be diagnosed with the naked eye? Is it good news or bad news that an improvement on one key of skillful jumping may be accompanied by a regression on another key? With frequent, varied, and targeted



Figure 5. Flight.

practice, most jumpers will have more successes than setbacks and will reach a high level of skillfulness.

Drill and Practice

One suggestion that applies to many of the keys to skillful jumping is that it may be instructive to separate the arms and the legs in practice jumps. For example, balance, range of motion, and speed of motion in the legs can be emphasized by using the armless jump in Figures 1-5.

The first type of jumping motion that children learn is to jump off a box or platform. In fact, most children develop this skill before starting school. To expand on this ability, landing from objects of various heights can be practiced. If a moderate progression of height over time is used, it is probable that students will gain both strength and confidence from this drill. However, to avoid soreness and injury, proper concern for cushioning must be exercised. Another suggestion, for developing full and vigorous contribution of the arms, is to provide a reachable, yet challenging, target above the head.

Balance in jumping can be practiced in a number of ways. Since many sport

jumps deviate from vertical, experience should be obtained by drilling on several kinds of oblique as well as vertical jumps. In this way, a jumper learns to control the target of landing. One activity which encourages oblique jumps is hop scotch. For variation, this game can be played by keeping the hands on the hips. A more advanced drill for practicing balance is the hexagon test. Described by Arnot and Gaines in the book *SportsTalent* (1986), this test has been used by Olympic coaches to identify talented skiers. As quickly as possible, the jumper makes clockwise progress around a 26-inches-per-side hexagon by alternately jumping inside or outside the hexagon and crossing each of the sides. For younger students, the hexagon could be scaled down and the element of speed removed.

Jumpers who have a reasonable mastery of balance seem to be able to vary the depth of the drop on suggestion. These jumpers might like to exaggerate both shallow and deep (but not too deep, for the sake of knee ligaments) jumps to see what gives the best results. Also, jumpers may be able to move more quickly by thinking about things like being "springy."

Coordination of the legs can be practiced at home by jumping on a pogo stick. To be successful, the jumper must stop when the stick stops and pop when the stick pops. One drill that may aid arm coordination is to have the jumper start from the stop position (the leg and trunk position of Figure 3). While in this position, the arms are moved behind the body and then moved forward to start

the jump; the challenge is to start the pop just as the arms pass vertical.

Of course, there are many other drills for jumping. Some of the best practice comes from participation in sports. Just remember, the drop is short, the stop is abrupt, and the pop is quick.

References

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