

Applying Biomechanics in Coaching

Coaching athletics also involves teaching motor skills to a wide variety of performers. Traditionally, careers in coaching have focused on working with the physically gifted in interscholastic athletics; however, there are many other levels of coaching: from parents who volunteer to coach their child's team, to the coach of a national team, and to a coach for an individual professional athlete. All of these coaching positions benefit from application of biomechanics in coaching decisions. Coaches use biomechanics to analyze technique, determine appropriate conditioning, and treat injuries (Elliott & Bartlett, 2006; Knudson, 2007b). Biomechanical knowledge is also important to coaches when coordinating efforts with sports medicine professionals.

QUALITATIVE ANALYSIS OF THROWING TECHNIQUE

Imagine you are a youth softball coach scouting the throwing ability of potential players. You set the players up in the outfield to see how well they can throw the ball to home plate. The technique points for overarm throwing and the cues one would commonly use are listed in Table 10.1. One young person trying out for the team shows a throwing technique like that depicted in Figure 10.1. What are the strengths or weaknesses of their performance in terms of biomechanical principles? Are these weaknesses you are confident can be overcome this season if they become part of your team?

The athlete in Figure 10.1 has a very immature throwing pattern, so he has weaknesses in several biomechanical principles. In fact, the straight arm sling this player uses likely places great stress on the throwing shoulder. The principle most in need of improvement is Range of Motion, which could improve with a more vigorous approach and a longer stride with the opposite leg. The Inertia of the throwing arm should be reduced in the propulsion phase by flexing the elbow to about 90°. The thrower does rotate their trunk away from and then into the throw, but Sequential Coordination that maximizes Segmental Interaction will require considerable practice. Like many young players, this person throws with a high initial trajectory, violating the Optimal Projection principle. The

Table 10.1
TECHNIQUE POINTS AND CUES
FOR OVERARM THROWING

Technique points	Possible teaching /intervention cues
Approach/stride	Step with the opposite foot toward the target
Opposition & coordination	Turn your side to the target
Arm position	Align your arm with your shoulders
Shoulder internal rotation	Range of motion
Angle of release	Throw the ball low and flat
Relaxation	Be loose and relaxed

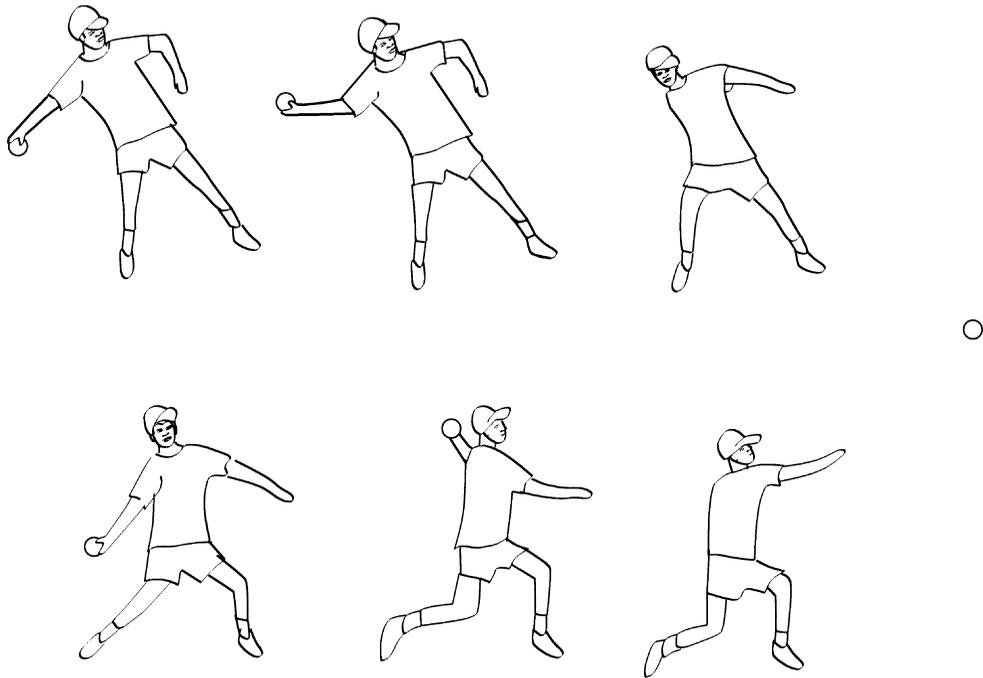


Figure 10.1. A softball player throwing with maximum effort to home plate from the outfield.

optimal throwing angles for maximum distance with baseballs and softballs are about 30° (Dowell, 1978).

Some of these weaknesses can be corrected quickly, but some will likely take more than a full season. The athlete should be able to improve his approach, arm action, and angle of projection. Fine-tuning coordination of his throw will likely take longer than a few months. The biomechanics of coordination in overarm throwing is quite complex (Atwater, 1979; Feltner & Dapena, 1986; Fleisig *et al.*, 1999). Consistent practice over a long period of time will gradually build the sequential rotation that optimizes segmental interactions to create a skilled overarm throw. To see if he listens and can easily change aspects of his throwing technique, ask him to step vigorously with his opposite foot and to throw the ball “lower.” It is possible that a youth softball coach might select this player for his team

based on other factors. Biomechanical technique in one skill may not be as important as motivational factors or the philosophy employed to help all players develop.

QUALITATIVE ANALYSIS OF DRIBBLING TECHNIQUE

Put yourself in the role of a youth soccer coach. After working on several dribbling drills, you begin a more game-like drill where one player consistently performs as in the illustration in Figure 10.2. Use the technique points and biomechanical principles in Table 10.2 to help guide your observation and qualitative analysis of Figure 10.2. What biomechanical principles are strengths or weaknesses in this performance? Diagnose the performance and decide what would be a good intervention to help this player improve.

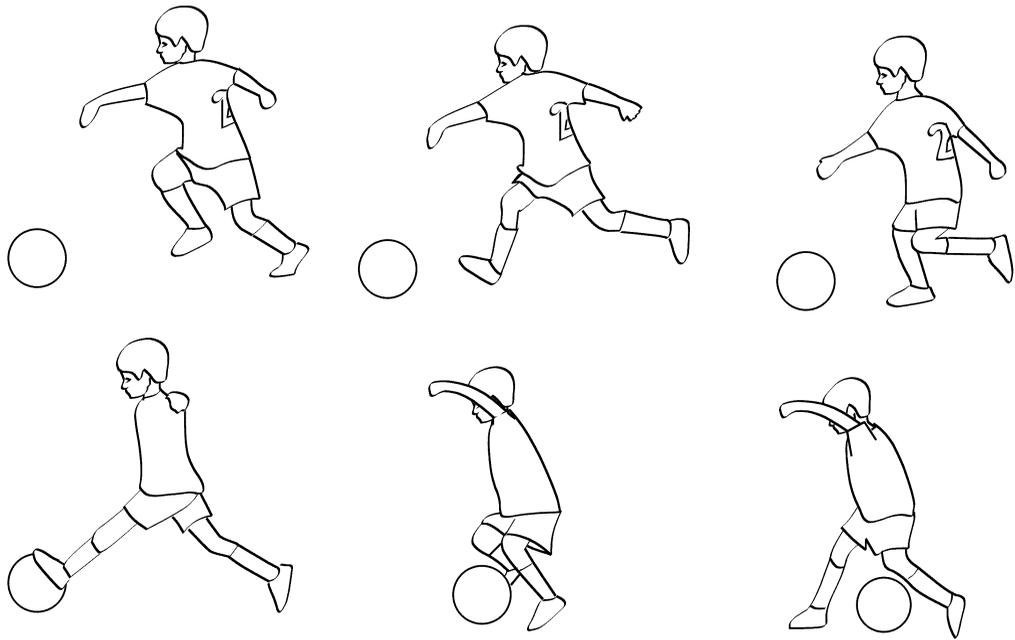


Figure 10.2. A soccer player dribbling during a scrimmage.

Table 10.2
TECHNIQUE POINTS AND CUES
FOR SOCCER DRIBBLING

Technique points	Possible teaching /intervention cues
Close to body	Keep the ball close to you
Kinesthetic awareness/control	Feel the ball on your foot
Awareness of situation	Head up and watch the field
Arch of foot	Push the ball with the arch of the foot
Angle of release	Keep the ball close to the ground

This young player shows good balance in this performance since he does not fall when stumbling over the ball. He has poor control of the ball, which likely contributed to him stepping on the ball. Despite a small

stumble, he uses his trail leg to recover the ball. The player needs to adjust their application of the Force–Motion and Range-of-Motion principles to improve their dribbling. Providing a cue that improves one of these principles will likely also improve the angle of release or the Optimal Projection of the ball. Let's diagnose this situation by prioritizing these three weaknesses to provide the best intervention to help this player.

Since this is a young player, you plan to praise his effort and a strong point before focusing attention on technique adjustments. Good intervention would be to praise his attention to the ball and recovery from the stumble. It is too early in this player's development to focus intervention on keeping his visual attention on the field. The best intervention may be a cue to “push the ball softly and keep it close to your body.” This cue combines the Force–Motion Principle and the Range-of-Motion princi-

ples and focuses the player's attention on correct technique. More specific cues on effort or range of motion can follow if future observations of his dribbling yield similar results. Note that a young player is not cognitively ready for complex technique or strategic instruction. The biomechanical complexity of dribbling a soccer ball in the dynamic environment of a game must be appreciated by the coach, but not imposed on a young player too soon.

QUALITATIVE ANALYSIS OF CONDITIONING

Junior high and high school coaches often are primarily responsible for developing conditioning programs for their athletes. Coaches must carefully monitor the exercise technique of their athletes to maximize conditioning effects and reduce risk of injury. Suppose you are a junior high basketball coach who has his players perform passing drills with a small medicine ball. The technique points and biomechanical principles you are interested in are listed in Table 10.3. One of your players shows the technique depicted in Figure 10.3. What biomechanical principles are strengths or

Table 10.3
TECHNIQUE POINTS AND CUES
FOR BASKETBALL PASSING

Technique points	Possible teaching /intervention cues
Stride	Step toward the target
Speed	Pass quickly
Arm action	Extend arms and thumbs down
Angle of release	Horizontal trajectory

weaknesses of their performance, and diagnose the situation to set up intervention.

The weaknesses in this player's exercise technique are related to stride, arm action, and angle of release. The relevant biomechanical principles for these technique points are Inertia, Range of Motion, Coordination, and Optimal Projection. While a variety of passing techniques are used in basketball, the one-handed flip with little weight shift that this player used is not the most desirable technique for high-speed passing. It is hard to judge from the timing information in the figure caption, so we will assume that the athlete used good effort and speed in executing the pass. Motivation clearly affects performance, so the

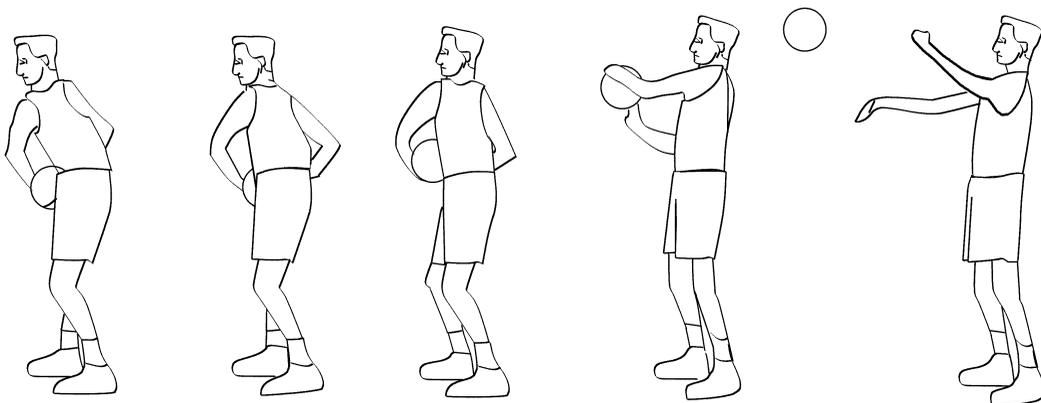


Figure 10.3. A junior high school basketball player throwing a medicine ball. Time between images is 0.12 s.

weaknesses in some athlete's exercise technique are more related to effort than to neuromuscular errors. The pass will likely have poor speed to the target since only the right arm contributes to the horizontal speed of the pass.

The coach must next diagnose these weaknesses and decide on the best intervention to help this player improve. A good coach would likely focus the player's attention on the correct arm action using both arms (Coordination). The primary reason for this diagnosis is safety, because the use of one arm and trunk twist to propel a heavy object may not be safe loads for poorly trained adolescents. There is also less research on upper body plyometrics than there has been on lower body plyometric exercises (Newton *et al.*, 1997), so what loads and movements are safe is not clear. Cues given for this technique point may also correct the angle of release, increase the speed of the pass, and enhance control of the ball. You decide to work on the stride later for safety reasons. Focusing intervention on the stride does not increase ball speed or decrease the distance (and therefore time) of the pass as much as good coordination with both arms would.

RECRUITMENT

As the golf coach for a university, you have many parents sending you videotapes of their children for potential scholarship consideration. These "daddy" videos can be a nuisance, but you qualitatively analyze the swings of the golfers on them for potential players you might have missed. This information combined with the player's performance in high school and tournaments will help you decide what athletes should be offered scholarships. The technique points and biomechanical principles of the full golf swing you use to analyze swings are presented in Table 10.4. For the player

illustrated in Figure 10.4, evaluate the strengths and weaknesses of their downswing. We will now focus on how the relevant biomechanical principles would help you diagnose the weaknesses of this player and her potential as a golfer on your team.

Table 10.4
TECHNIQUE POINTS AND CUES
FOR THE GOLF SWING

Technique points	Possible teaching /intervention cues
Weight shift	Push with rear, then the front foot
Swing plane	Swing forward and back on same plane
Backswing	Slow and club not past horizontal
Tempo/coordination	Delayed release of the club
Impact/shot trajectory	Divot in front of ball
Follow-through	Long slow finish

This player has an excellent full swing and control of the club. It is difficult to tell from this perspective, but it is likely this player keeps the club in a stable swing plane. The swing has an appropriate range of motion since the backswing terminates with the club virtually horizontal. The player has a good weight shift, hip and trunk twist, and a firm forward leg late in the swing. The follow-through is fine. The two technique points that are difficult to judge from the video (and from the figure) are the Coordination of the swing and the quality of the impact and shot trajectory (Optimal Projection). In short, this particular player has several strengths that suggest she has an excellent golf swing. A good golf coach would be aware of the massive amount of research on the golf swing (Neal & Wilson, 1985; Springs & Neal, 2000; Williams & Sih, 2002). There are no obvious

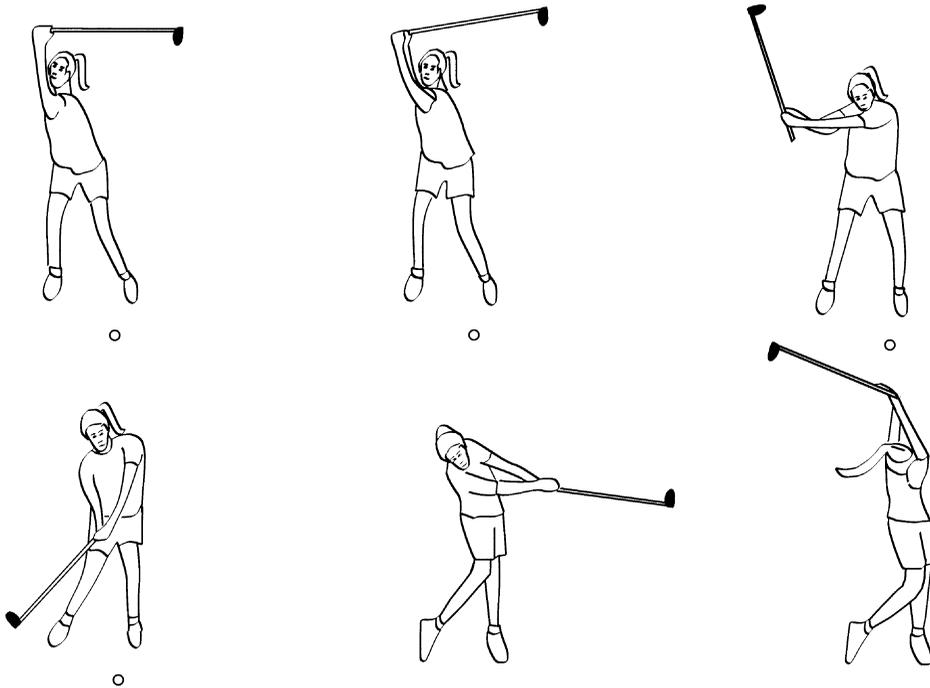


Figure 10.4. The long iron swing of a prospective golf recruit.

warning signs, but a complete diagnosis of this golf swing is difficult to obtain from a single video.

It is possible that the tape was edited to show only the best swings for many shots. To fully diagnose this golf swing, you clearly need to know about impact and shot trajectory relative to the intended target. The sound of the impact might suggest that the ball is well hit; only observation of the ball's flight relative to the intended target will provide clues as to the player's potential and the many subtleties that set high-level golfers apart. A nearly perfect golf swing that strikes the ball with the club face angled away from the target or off-center can produce very poor golf shots. A good golf coach using video for qualitative analysis would get views from several vantage points and gather information on the flight

of the ball. This distance and direction information can be written or in recorded form on the audio track of the video. Only an integrated qualitative analysis of all these factors over many strokes would allow the coach to correctly judge this player's potential.

Note how a diagnosis of possible strengths and weaknesses is severely limited when all we have is a single view of a golf swing. Remember that the biomechanical principles related to the golf swing also must be integrated with other kinesiology disciplines. This player might have a flawless swing in practice that turns rough and unpredictable under psychological pressure. If this player's tournament results are good, the coach might invest time talking to their high school coach and plan a trip to see them in action.

QUALITATIVE ANALYSIS OF CATCHING

As a volunteer youth football coach you are working with your receivers on catching passes. Many young players pick up bad habits from playing neighborhood pick-up football games or watching the pros get by with talent rather than optimal technique. The technique points and cues you typically use are listed in Table 10.5. Notice how the critical features are more advanced and specialized than the catching technique points in chapter 9 (e.g., Table 9.4). Which biomechanical principles are strengths and weaknesses in the catching illustrated in Figure 10.5? How would you diagnosis this situation and intervene?

The player in Figure 10.5 made a successful running catch, but the illustration does not show enough of the movement so that we can tell whether the player protect-

Table 10.5
TECHNIQUE POINTS AND CUES FOR
CATCHING A FOOTBALL PASS

Technique points	Possible teaching/ intervention cues
Visual focus	Watch the ball, look for the seams
Intercept	Move and reach towards the ball
Hand position	Thumbs in or thumbs out
Absorption	Give with your hands and arms
Protection	Give and tuck the ball away

ed the ball by tucking it into their body. The illustrated view makes it difficult to tell if the player extended his arms (Range of Motion) to intercept the ball and provided time (Force–Time) to absorb the kinetic energy of the ball. Not only is reaching for the ball important in being able to increase the

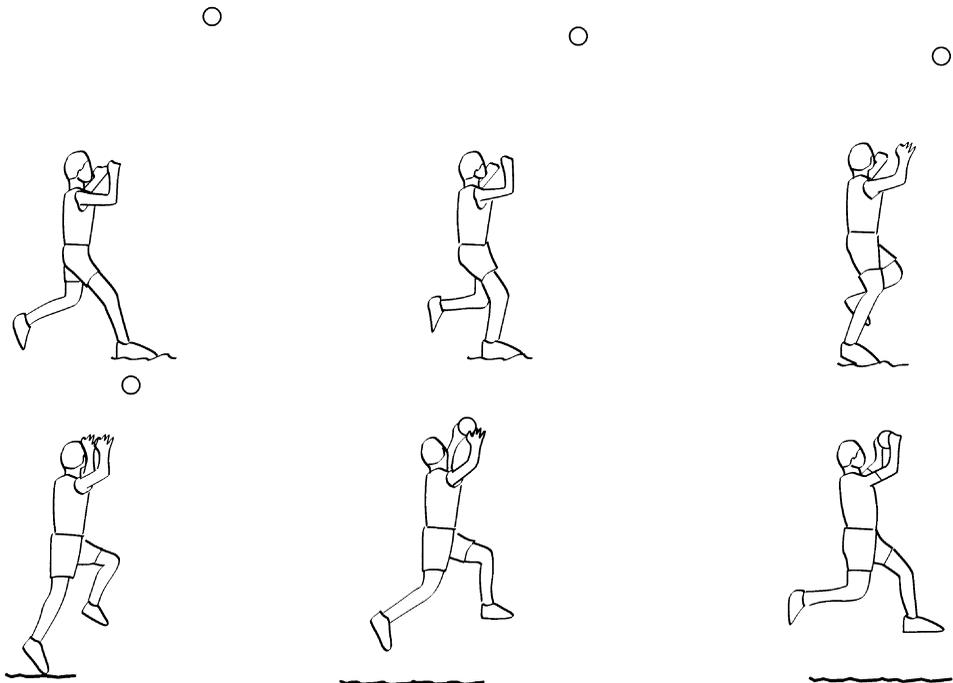


Figure 10.5. A football player making a catch in practice.

time of force application in order to slow the ball, but visual information on the arms/hands may also help intercept projectiles (van Donkelaar & Lee, 1994). Evaluation of this performance does not clearly identify any weaknesses in application of biomechanical principles.

A good intervention strategy would be to praise the player's effort and visual focus on the ball. Reinforcement of important technique points and motivation are good intervention goals while the coach waits to see if subsequent trials demonstrate no major weaknesses. How might the coach increase the difficulty of the catching drill to see if poor technique develops? Catching in a game situation involves many more environmental distractions. A knowledge of research concerning technique errors (Williams & McCririe, 1988) and environmental constraints (Savelsbergh & Whiting, 1988) in catching is clearly relevant for coaching football. What would be a better perspective for the coach to observe if the player is really reaching away from the body to intercept the ball?

SUMMARY

Coaches employ the principles of biomechanics to qualitatively analyze the movements of their athletes. This chapter explored the use of biomechanical principles in coaching softball, soccer, golf, football, and conditioning for basketball. Like physical educators, coaches often use cue words or phrases to communicate intervention to players. Coaches must integrate biomechanical principles with experience and other kinesiology subdisciplines (Knudson & Morrison, 2002). For example, coaches most often need to take into account conditioning (exercise physiology) and motivational issues (sports psychology) when dealing with athletes.

DISCUSSION QUESTIONS

1. Are certain biomechanical principles more important to the advanced athlete? Which and why?

2. Athletics coaches often have the opportunity of working closely with a smaller number of performers over a greater length of time than other kinesiology professionals. Does this concern for long-term performance increase or decrease the importance of biomechanical principles?

3. Have coaching organizations adequately promoted continuing education in sport sciences like biomechanics?

4. Which biomechanical principles are relevant to athlete quickness? Can biomechanics be used to coach an athlete to be quicker? If so, how does this improvement compare to improvement from conditioning?

5. Are biomechanical principles relevant to talent identification?

6. While the "daddy" videos discussed above might give the coach a general indication of the swings of players, what important aspects of golf competition may not show up on these videos? What important biomechanical issues might be difficult to determine from inadequate camera views?

7. Prioritize the following factors based on their importance in coaching beginning, intermediate, and advanced athletes for a specific sport: biomechanics, maturation, physiology, psychology.

SUGGESTED READING

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WEB LINKS

ASEP—American Sport Education Program, which provides resources for developing coaching skills.

<http://www.asep.com/>

CAC—Coaching Association of Canada, which provides coaching development resources.

<http://www.coach.ca/>

CIS—ISBS Coaching Information Service, which provides articles applying biomechanics for coaches.

<http://coachesinfo.com/>

The Coaching and the Australian Sports Commission.

<http://www.ausport.gov.au/coach/index.asp>

The Sport Journal—A coaching journal published the US Sports Academy.

www.thesportjournal.org