Formative and Summative Assessments for Mastery Learning in Physical Education

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Collecting and using data effectively in coaching and teaching physical education can include sharing data with the student athlete. The value and usefulness of both formative and summative assessments in guiding the training and coaching of individual students has been emphasized. A *Mastery Learning* model can bring these elements together to provide an individualized, data-driven approach to improving athletic performance and achieving training goals.

Normally applied to classroom or academic settings (to distinguish from training or sports endeavors), Mastery Learning has accounted for success rates reaching 95% mastery as compared to the common bell curve distribution of a traditional approach (Davis & Sorrell, 1995). If coaches and trainers can employ a Mastery Learning approach it is not unreasonable to hypothesize that athletic performance could mirror those achievements.

This paper looks at two issues: (a) how data may be objectively collected in sports and training situations to (b) inform and guide the coaching/training program by including the student athlete in the process. This paper suggests research to examine coaching and teaching practices regarding how data is collected, analyzed and ultimately shared with the athlete students to inform the training process. Research can provide comparisons with a Mastery Learning model perspective and suggest training for coaches and teachers to employ such principles.

Statement of the Problem

The problem is that, lacking current, reliable data, it is unknown whether sports coaches and Physical Education (PE) teachers (a) conduct formal assessments, and (b) share raw data and analysis with their student athletes. Advancements for athletes in sports training and achievements in physical education depend on accurate and reliable information, scientific data collection methods and sound assessment strategies (Morton, & Lieberman, 2006).

Raw vs. Standardized Data

Raw data is collected all the time as coaches (and physical education teachers) observe the behaviors and performances of their student athletes. These include numeric data such as speeds, times, weights, distances, temperatures and more. Observations will also take note of more subtle or complex information such as terrain inclines, slopes, path curvatures. Coaches will often take note of humidity, wind speeds and more. These and countless other sorts of information make up the raw data collected habitually and instinctively by attentive and experienced coaches. However, such raw data collection might better be described as perception, supposition and opinion if not mere conjecture and speculation. It simply isn't scientifically controlled – or standardized.

Certainly, many experienced coaches, having been performance athletes themselves, can perhaps estimate such data very accurately and make very precise observations. Indeed, there may be a high correlation between the informal, field-based observations of experienced coaches and what might be found in laboratory or controlled settings but no research has been found examining that relationship.

In any event, accuracy and precision in raw, field-based data collection is still not the same thing as controlled data in a clinical, laboratory setting. Among other concerns, two big differences might be how such circumstances can be (a) consistently replicated over multiple trials, and (b) directly manipulated to consider alternate cases. For example, humidity (one of many environmental issues) can vary widely across several days of training and is, along with most variables in the field, completely out of the coach's control. Therein lies the problem. Raw, field-based data naturally and regularly collected by coaches cannot be equated with controlled clinical measures. They remain two different types of data and serve different purposes.

Subjectivity vs. Science

As discussed above, coaches will naturally engage in informal data collection by observing athlete performance in association with various conditions. But, student athletes will also engage in this casual observation. They are inclined to develop opinions and perspectives. They might feel better following a race or other trial and interpret that as a sign of success or improvement without scientific justification. Coaches, too, can see a faster speed or an increase in weight lifted or other numeric advancement but fail to scientifically consider the impact of other variables in the field that might affect those results. There is no point in making an exhaustive list (humidity, terrain, noise, etc.) as they are virtually unlimited. The subjectivity of impression and the bias of preference must inevitably taint the prescription from coaches and teachers and the cybernetic feedback in the student athlete. They will develop their own perceptions of teacher expectations, competition and the demands of the sport (Constantinou, Manson, & Silverman, 2009). Such subjectivity can be tempered by scientific data collection in a controlled setting.

Disclosure and Mastery Learning

Few coaches share data with the athlete. And, when they do, they tend to share minimal information or casual feedback. But, failing students, those who really need it, tend to reject it. (Mascret, 2011). The athlete can become an active participant, a kind of coaching partner. Student athletes are sensitive to the nature of the feedback and the source of the data (Liu & Chepyator-Thomson, 2009).

Davis and Sorrell (1995) explain how Mastery Learning is certainly not a new idea. In these principles, aptitude might be defined not in terms of one's capabilities or talents but instead as the time it takes to reach the objective. Assessments in Mastery Learning are formative as they prescribe and redirect the learner to remediation even looping through learning cycles allowing more time and training for mastery achievement.

It is proposed here that the student athlete is a necessary and inevitable partner in that endeavor. It is suggested here that Mastery Learning demands informed retrial, not blind and ritualized repetition. The student athlete must be empowered in that partnership and that requires reliable information (Donohue, Dickens, Lancer, Covassin, Hash, Miller, & Genet, 2004).

So, the importance of collecting objective data and sharing that with the student athlete cannot be over emphasized (Neide, 1996). There are many methods for doing so. Stillwell (2002) outlines a model for collecting and sharing objective data. The key points involve targeting and defining specific behaviors, coding and observation instruments, observer reliability and data analysis. Also emphasized is the importance of providing feedback to athletes who are, again, a necessary and inevitable part of the training process.

Ideally, assessment becomes a part of the feedback process and supports data from a laboratory or scientifically controlled setting (Petersen, 2008). Specialized equipment, while not available everywhere, can generally be found a local colleges and sports centers. Methods, unlike high-tech equipment are of course available to everyone. A stop-watch and distance measure are cheap and readily available everywhere. While this paper will look at that equipment and those methods, it has been emphasized that using feedback appropriately can empower student athletes and make ones coach a mentor in the training process (McFarland, 2001).

The habits of coaches who fail to collect and use data scientifically are clear obstacles to change. Whether due to a lack of understanding, a lack of means, or even ego, the challenge must also recognize that teachers notoriously experience frustration and resistance to any change (Gubacs-Collins, 2007). The introduction of the Mastery Learning model can provide principles and guidance for helping coaches collect and use the data necessary for athletes' goal achievement.

Assessments and Data Collection

An example of data collection in the field that can be misused and misunderstood includes the timed race. The times may be considered objective data but they are severely limited and provide little or no basis for real analysis. Yet, such measures are not uncommon and far too often serve as the exclusive measure for guiding training. Consider this example for the first race: Allen (A) and Bob (B) race 100 meters against each other and against the clock. It is discovered that Allen is faster than Bob (figure 1). While A is quicker than B and won the race for this 100m example, performance data alone is limited in its ability to more comprehensively inform training. Allen's time was 11.4 seconds but Bob required 13.4 seconds. Even timed, the numbers merely quantify

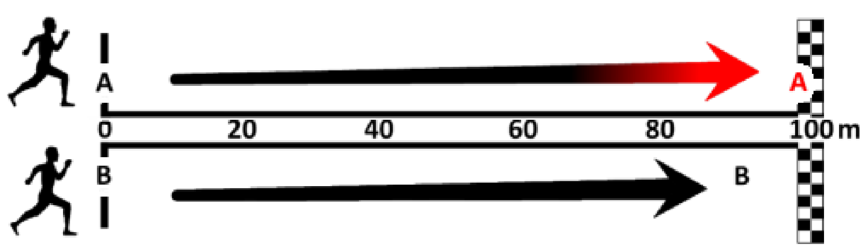

Figure 1. *Timed race results with A over B.*

the same fact, that Allen is faster. But, what does this data not provide? What does the coach need that is not included in this data?

Performance is a *net product* of many variables. Consider this second example for the first race in which multiple measures are made at 20m intervals. This more scientific approach can reveal that Bob was actually ahead during the first 40 meters of the race (figure 2).

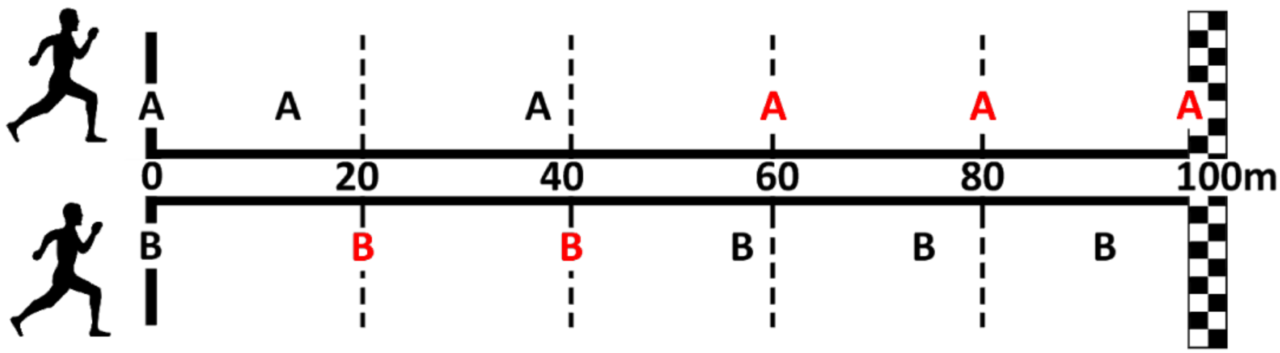

Figure 2. *Illustration of more detailed assessments at 20m intervals in the first race.*

These additional assessments address important questions and illustrate a much greater range of data that can be critical in a more informed evaluation of a runner's needs. Who has the better reaction time? Better acceleration? Better top speed? Better ability to maintain top speed (i.e. not slow down)? Better Biomechanics/running form? Highest lactate/anaerobic threshold?

As illustrated, meaningful *objective* assessments should yield more than just a total time. The beginning of a race (0-20m) reflects a runner's reaction time and acceleration. Acceleration continues through the early portion (20-40m) of a race. The middle range of a race (40-80m) shows a runners' top speed ability. The end of the race (80-100m) reflects a runner's ability to maintain their top speed over an extended time. A range of strengths and weakness can be seen more clearly and coaches can better prescribe a detailed and personalized training regimen.

Another example, the second race between Aaron (A) and Ben (B), again illustrates the value of detailed measurements. Both runners tied in the race at 11.4 seconds each (figure 3). It would seem that both runners are evenly matched and, in that sense, the same. Indeed, even many watching the race in-person thought Aaron and Ben were neck and neck throughout the whole race. Only a more detailed and objective assessment with measures specifically focusing on the points at 20 meters and 40 meters reveal some important differences between the runners.

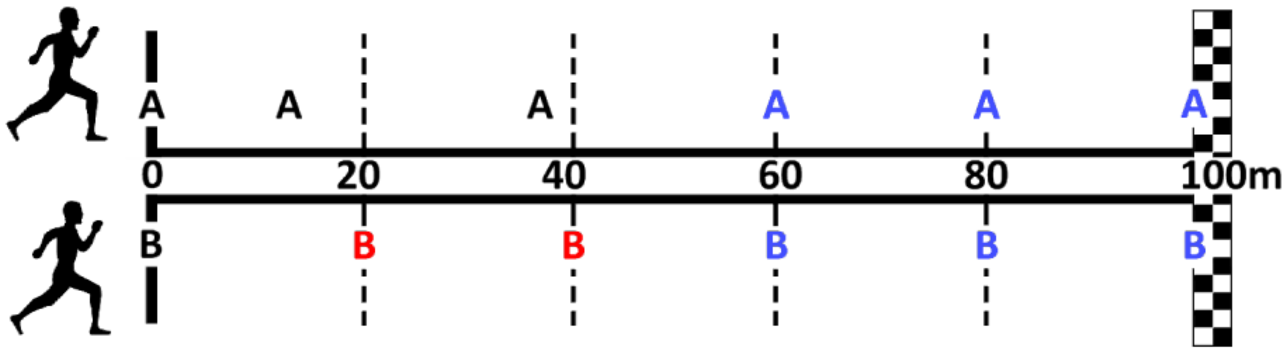

Figure 3. *Second race showing detailed assessments with runners tied.*

Are Aaron (A) and Ben (B) really the same? Should they train the same? Aaron has greater top speed relative to his other running points than Ben. Ben has a better reaction time and acceleration than Aaron but lower relative top speed. Both runners' independent talents and abilities came together resulting in the same completion time. But, while both runners have a similar ability to maintain top speed, their individual profiles are different. This can be critical for a personalized training program.

The 100 meter race is only one choice compared to the longer 440 or other variations in distance. What distance would be best for Aaron in race 2? Would Ben have been able to continue to match Aaron's time if the race were extended? With an analogy from the sport of professional boxing, changes in duration can have obvious and profound effects on results. Since the very old days of bare-knuckle boxing, to the more modern structure of timed rounds, going the distance is a key variable. Aside from safety, economic or political ramifications, boxing did change from 15 rounds to 12 in 1982 (WBC) and 1988 (IBF) having a considerable effect on many title bouts (Wikipedia, 2011). Some boxers can do better in the later rounds now missing in today's pugilistic limitation. Some runners excel early while others reach their stride and excel nearer the end. More to the point, coaches need to know how develop training programs to overcome weaknesses and, while strength and weaknesses are sometimes perceived informally and unscientifically, those notions may not be reality.

Individualized Assessment

Mastery Learning involves cycling through repetitive training experiences until the goal is achieved. This requires formative assessments that inform the trainer so the learning cycle is intelligently managed and not merely uninformed, ignorant ritual or, worse, a matter of subjectivity, assumption, or bias.

Objective test data can overcome perceptions for both the coach and the athlete student when individualized and shared. A key assessment tool, very useful in sports training, is the Metabolic Gas Analyzer (figure 4). Data collection in a laboratory setting allows for the maximum control of extraneous variables. This particular equipment and software (combined) measures the amount of expired CO_2 & O_2 to determine exercise intensity, the dominant fuel source (Fat, Carbohydrate or Protein), number and volume of breaths and much more. These measures along with Blood Lactate Analysis and an assessment of Biomechanical behaviors can yield a highly individualized profile to inform the coaching process.

Image from: www.aeitechnologies.com

Figure 4. *Metabolic Gas Analyzer used in individualized assessment.*

Summary

In summary, Mastery Learning suggests that students can achieve learning goals given sufficient time on task. Also presumed is intelligent and individualized feedback to guide remediation in the learning cycle. As discussed above, two elements are vital in this process: (a) objective data scientifically collected and (b) sharing this data and analysis with the student athlete. A partnership is important in coaching and training wherein the athlete shares in both the prescription and execution of training. Further research is planned to look at coaching practices for both of these elements among both high school and college-level coaches and physical education teachers.

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