Introduction to Nonlinear Assessment

Globally, Physical Education (PE) has been competing to maintain its importance in schools alongside other academic subjects (MacPhail & Halbert, 2005). In Singapore, with the PE syllabus recently revamped to increase its importance to the education curriculum and a new syllabus being gradually rolled out (in phases since 2014), PE teachers have been challenged to revise lesson planning and plan for appropriate assessments. Furthermore, there is an increasing demand from stakeholders (both parents and policymakers) that PE programs state clearly the intended outcomes and provide effective assessment (Rink & Hall, 2008). Taken collectively, this has compounded the need for increased ongoing assessment (both formative and summative) of students' performance. Notably, despite the nuances involved in conducting formal assessments, research on assessment practices (e.g. Collier, 2011; López-Pastor et al., 2013) have highlighted that any form of formal assessment of student learning would be a welcome step in the right direction.

Assessment in PE can be divided into two categories: assessment of learning and assessment for learning. Education in general has seen a shift from "assessment of learning" to "assessment for learning" (Black & Wiliam, 1998; Broadfoot & Black, 2004; Hay, 2006; Wiliam, Lee, Harrison, & Black, 2004). Each is structured in different ways and serves distinctly different purposes (Hay, 2006). The latter is often seen in large-scale standardized or criterion-referenced tests such as the traditional NAPFA Tests, whereas the former focuses on purposeful tasks of higher-order thinking and learning that can be transferred to other settings outside of the gymnasium (Hay, 2006).

Siedentop and Tannehill (2000) as well as Hay (2006) noted that an "assessment for learning" perspective calls for the use of 'alternative' assessment tasks that not only differ from the formal tools traditionally used in PE but also allow students to demonstrate the skills and knowledge that can be applied in real world contexts. Assessment can be described as authentic if the addressed behaviour is demonstrated in real-life settings rather than artificial or simulated settings. It is redundant if the knowledge, skills, and concepts learned in PE are not transferrable to real-life settings. Therefore, it is imperative that teachers provide modes of assessment in which the students will utilize these authentic aptitudes and abilities. Alternative assessments can become authentic when they are structured to elicit higher-order thinking skills, such as problem solving and *decision-making* from students with the objective that such skills can be applied to a real-life setting (Schiemer, 2000). A typical example of authentic assessment in a table tennis lesson would be that students are assessed based on his or her performance in an actual table tennis rally, instead of, dropping and hitting a table tennis ball from a stationary position, using a forehand stroke, to a designated target in the opponent's side of the table.

According to Desrosiers, Genet-Volet & Godbout (1997), Authentic Assessment has three typical features. Firstly, it is integrated within the teaching-learning process. Secondly, the assessment procedure is shared with the students and finally, assessment is formative in nature. Nonlinear Assessment (NLA) shares these features and aims to complement Nonlinear Pedagogy by advocating the need to include formative assessment based on key Dynamical Systems Theory (DST) phenomena like *Hysteresis* and *critical slowing down* within a games concept approach (GCA) lesson. In a recent study by Wan, Chow and Rein (2017, journal article under review), it has been ascertained that both *Hysteresis* and *critical slowing down* may be utilised as a form of assessment.

An implication about *Hysteresis* is to consider planning practice tasks that include a selection of learning scenarios that explores both space and direction through systematic scaling as compared to static tasks that leads to repetitive movement pattern only. Through systematic scaling, learners would exhibit exploratory behaviours and discover a myriad of functional movement patterns. For example, (see Figure 1 below), in a basketball assessment, instead of shooting from a fixed location, the shooter may be allowed to shoot from different locations and distances but not randomly.
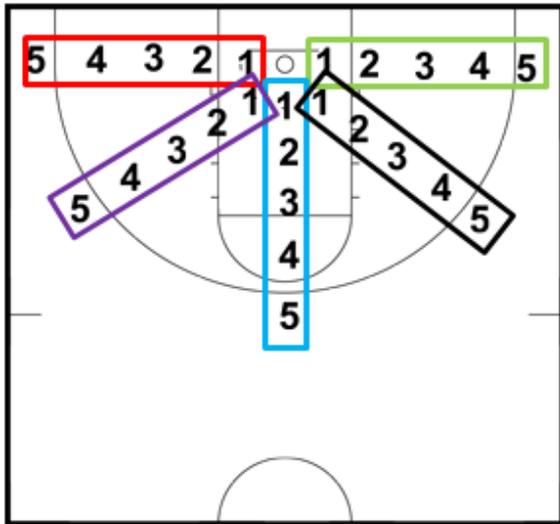

Figure 1: Basketball shooting positions

The shooter can start shooting from red 1 before moving to purple 1, blue 1, black 1 and finally to green 1 before scaling back in the other direction. Alternatively, the distance (from basket) can also be manipulated. The shooter may begin from red 1 and end at red 5 before scaling back. As the shooter moves from location to location, they are able to discover and attempt the most suitable shot for different locations. For example, if they are near to the basket they may attempt a standing layup or a hook shot instead of a jump shot. Conversely, if they are beyond the three point line, they may attempt a jump shot that is more suited for that distance as compared to a jump shot that is within a two-point zone. The impetus here is on the teacher to identify what is the number of possible movement solutions for recording purposes. For example, a hook shot, a set shot, a jumper. Additionally, the teacher might want to add important elements such as shots that are hallmarks of a skilled player. For example, a wrist follow-through (e.g. the cookie jar analogy by Krause, Meyer, & Meyer, 1999, pp. 72–73) or releasing the shot at the highest point of jump. Assessment in this case, may be recorded as seen in Figure 2. It can also be modified so that it can be recorded by the students individually or in pairs.

Basketball Assessment task 1

Objective: Throw the basketball from the specified location into the target.

Record your observations below:

Colour	Location 1	Location 2	Location 3	Location 4	Location 5
Red					
Purple					
Blue					
Black					
Green					
Green					
Black					
Blue					
Purple					
Red					

Figure 2: Basketball assessment record card for *Hysteresis*.

Alternatively, manipulating duration may also be adopted. In that regard, the teacher may consider dividing the situational game into six mini situational games (divided in to periods) with each period being allocated different timings and these timings are scaled (see *table 1* below).

	Period 1	Period 2	Period 3	Period 4	Period 5	Period 6
Time allocated (seconds)	45	90	120	120	90	45

Table 1: Duration of mini situational games to elicit *Hysteresis*.

Using a modified game of basketball to exemplify *Table 1* above, the mini-situational games within each would create possible scenarios that may be observed in matches. For example, the first minute in a game and the last minutes in a game (when the scores are tied) are usually at a frantic pace. Similar to the prior example, the objective in this game for the attackers is to score a basket whereas the defenders are to prevent a basket from being scored. The period ends according to the specified time and the game begins with a new (next) duration. At the end of six periods, the roles would switch. As the time is scaled from less to more and to less again, we would expect the intensity of the game to increase, decrease and increase respectively. It may be speculated at this juncture that an increased/ decreased intensity would result in a myriad of organizational patterns and scenarios that would further encourage *decision-making*.

Finally, it is interesting to add that the suggestions above may be incorporated with evolving technology. For example, most of the assessments and task cards may easily be recorded on a tablet and synced to a cloud system where the results would inform the students or players of their performance and areas for improvement in real-time whereby may use the tablet during lessons and training sessions and advance or progress at their own pace. It is possible to get students to work in pairs and peer assess one another. They may record observed movement patterns and critically, with the data collected, their hysteresis region may be available. The information on these movement patterns may be extracted and be used to inform the player as well as the teacher on how to improve performance.

To summarise, assessment in PE has progressed in importance over the years. There is an increased demand from stakeholders to substantiate the learning and the effectiveness of its programmes. There is also a need to conduct formal assessment in school that are non-traditional and goes beyond learning for assessment. Assessment for learning has now taken centre stage and it is imperative that PE teachers structure alternative, authentic and meaningful methods of assessment for learning. Methods or approaches like Authentic Assessment should not only identify whether or not a student has successfully achieved a lesson or unit's objectives but should be relevant to students by allowing for the transfer of skills and knowledge into other disciplines and real-life scenarios. In this regard, Nonlinear Assessment offers itself as an option that can be seamlessly infused in GCA-based lessons.

In NLA, there is a conscious need to record the results that would empower the teacher with information concerning the learner's current ability or chart the learner's improvement over a period of time. The examples provided in this article also demonstrate the applicability and extendibility of this programme of study across other sports. Finally, the use of technology in NLA should be considered. With evolving technology, the possibility to harness technology to enhance teaching and learning can be maximised.

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