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How can we best measure fundamental movement skills?

Beth P. Hands

University of Notre Dame Australia, bhands@nd.edu.au

Running Head: Measurement of Fundament Movement Skills

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Beth Hands
University of Notre Dame

Send correspondence to:

Dr Beth Hands
School of Health and Physical Education
College of Health
University of Notre Dame
PO Box 1225
FREMANTLE WA 6959
Ph: (618) 9239 5792
Fax: (618) 9239 5790
Email: bhands@nd.edu.au

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Abstract

The assessment of movement skill is a critical component of many disciplines and professions. In particular, the effectiveness of movement programs hinges on accurate information about the skill level of participants. This information should be based on assessment that is valid, comprehensive, educative, fair and explicit. The chosen process is matched to the assessment purpose. In this paper, the advantages and disadvantages of quantitative and qualitative strategies will be presented and the areas for future research highlighted.

Introduction

The assessment of movement skill is a critical component of many disciplines and professions. Although the specific contexts and applications may vary, the basic concepts and strategies are similar. In order to plan efficient and effective movement programs or to support the involvement of a child with special needs in the wider community, it is important to gather information about the motor skill level of the child and what best motivates them, their strengths and needs. Generally, this information should be gathered in a range of settings and over a period of time using methods matched to the setting and the purpose. Consideration should also be given to factors that may affect children's learning of Fundamental Movement Skills (FMS). These include environmental factors such as the family and community values, expectations and support, and opportunities to practice and child specific factors such as age, physique, health, interests and motivation (Gallahue & Ozmun, 1995).

Assessment Methods

There are a several different ways to measure children's performance of FMS, each with advantages and disadvantages. The assessor must take these into consideration when deciding what approach to take. The decision on how to measure children's FMS performance will be guided by the purpose of assessment. What information is needed and why? The purpose may be to appropriately group a class of children, to identify those at risk, to plan intervention or educational programs, to monitor change over time, to provide feedback to the performer or to predict performance in the future (Burton & Miller, 1998).

Quantitative Assessment

Quantitative assessment approaches involve measuring the product or outcome of the performance. The item score is a number or quantity, for example the time in seconds to run 50 metres, the distance in centimetres jumped, or the number of successful bounce and catches in 20 seconds. The result is usually compared to the performance of a normative group. The scores are converted or transformed into relative scores such as standard scores or percentiles. Such information enables the comparison of a

child's performance to their chronological peers and could be used to screen for children with movement difficulties or to select participants eligible for a movement program. For example, the Western Australian FMS Teacher Resource (EDWA, 2001) includes a four item screening test, Stay-in-Step, that teachers may use to identify children with poor coordination skills (Larkin & Revie, 1994). The objective nature of the measures generally ensures a high level of reliability over time and between assessors (Spray, 1987). Further most tests can be done quickly and are capable of testing large groups. As the tester does not require an extensive understanding of movement competencies to administer the test, this approach is useful for generalist teachers or professionals without a background in human movement (Hands & Larkin, 1998).

On the other hand, the test outcomes do not inform the intervention or teaching program as they do not provide direct information about the proficiency of the performance (Branta, Haubenstricker, & Seefeldt, 1984). For example, if a child's 50 metre run time means they are performing below the 10^{th} percentile for their age, the coach or teacher may not know why. When children are still mastering motor skills, their movement patterns are often extremely variable. The information gathered through quantitative measurement techniques is not able to discern between levels of variability in movement patterns. Is the slow run time due to a short stride length, erratic arms, low knee lift or all of the above? Finally, the validity of the test results depends on the appropriateness of the normative group for the child or group being tested. Physical factors that impact on performance such as height, weight and body composition, and differing cultural expectations and interests are not taken into account when interpreting the scores.

These measures are most often used for the assessment of FMS during school athletic or swimming carnivals, or programs such as Little Athletics. For example, children compete against others of their same age and usually gender to identify the fastest runner, fastest swimmer or highest jumper.

Qualitative Assessment

In recent years, the most frequently used FMS assessment tools with children employ qualitative measures which focus on the form or technique of the movement, in other words, how the skill is performed. Knudson and Morrison (1997, p. 4) define qualitative assessment as "the systematic observation and introspective judgement of the quality of human movement for the purpose of providing the most appropriate intervention to improve performance."

Observation records or checklists for each FMS are usually generated to facilitate this approach FMS assessment. There are two schools of thought about how these observation records are structured. Each approach stems from a different theoretical approach to motor development. One is the Global or Whole Body approach and is associated with Seefeldt and colleagues (Branta et al., 1984; Seefeldt & Haubenstricker, 1982). The levels or stages for skill development are global in that the movement of the arms, legs and trunk are described for each stage. All body components progress in unison towards greater levels of efficiency. An observation record based on this approach includes descriptors for each body part for each defined stage of learning (Seefeldt & Haubenstricker, 1982). On the other hand, Roberton (1977) developed the Component Stage Theory which states that body components develop at their own rate and therefore should be assessed independently. In the development of the overhand throw, for example, Roberton has shown that the arm action will develop independently of the leg and trunk actions and that the patterns will vary between children. Even within a body component, such as the arm, individual patterns for the upper and lower arm have been shown. Generally, skill performance is described within phases of performance such preparation, propulsion and follow through. Subsequent research has now identified component stages for a number of FMS (Clark & Phillips, 1985; Halverson & Williams, 1985; Langendorfer, 1987). These studies have significantly contributed to our understanding of motor development, but have made assessment of FMS more complicated.

A less complex approach to assessment using component stage theory is the 'mastery' or 'proficiency criteria' model which describes the key actions of the main body parts for the proficient form of the action, rather than patterns that may be observed during

the learning of the skill. These criteria do not represent a developmental sequence nor fully describe an instructional sequence but comprise certain key aspects for a proficient performance. This approach has been adopted for most Australian FMS teacher resource packages. The assessor records the key components of the skill being demonstrated by the performer. For example, do the arms move in opposition to the legs while running, is the head stable, are the knees lifting high? Those components not demonstrated become the focus for future interventions.

Australian researchers have used qualitative techniques in several studies to report on FMS development in children. Walkley and colleagues (1993) qualitatively evaluated the FMS levels of proficiency of a 1182 Victorian school children in Years 2, 4, 6, and 8 using skill components developed specifically for the project. They reported low levels of proficiency for all skills based on mastery of skill criteria. Mastery was defined as the demonstration of all, or all but one, of the skill criteria.

The Department of Education in Tasmania in conjunction with the University of Tasmania used the Test of Gross Motor Development (Ulrich, 1985) to measure FMS levels in 574 children aged 7 and 10 years (Cooley, Oakman, McNaughton, & Ryska, 1997). This formal test provides qualitative performance criteria for 12 skills, and the scores are converted to standard scores and percentiles for children aged between 3 and 10 years. The disadvantage of this test is the norms were developed for American children. In the Tasmanian study, the 7-year-old children compared favourably to the American standards but 10-year-old children were categorised as below average. The authors suggested these differences could be due to environmental influences.

The major advantages of qualitative assessment are the information can be used to inform the teacher or movement professional which specific components of a skill an individual needs to practice, and the assessment can be undertaken in a more meaningful context than quantitative methods. Most quantitative test items need to be performed in controlled settings, for example a 50-metre times sprint must be measured on a marked track. An observation record for a child's run could easily be completed during a game or class activity, or even during school recess. The negative aspects of qualitative assessment include the difficulty of comparing results that have been gathered by different assessors. Assessors may interpret components of

movement differently unless intensive training has been undertaken. For example, how high is a high knee lift? Inter-rater reliability, therefore, is generally quite low. This approach can be very time intensive. The time required to assess a large number of children, for example a school class, is high. Further, it is difficult to interpret information gathered as the results usually have no normative data. What cut off scores define mastery or proficiency? What key components are most important in order to master the whole skill? Are some aspects of the skill easier than others? Much of this information is available, but to date not easily taken into account in assessment measures.

How many skill components are enough?

FMS assessment tools involving observation records vary in complexity and number of skill criteria for any one skill. McIntyre (2000) analysed video footage of children performing the overarm throw using 3 different assessment tools. These were the Test of Gross Motor Development (Ulrich, 1985), the Fundamental Motor Skills- A Manual for Classroom teachers (Victorian Department of Education, 1996), and the Fundamental Motor Skills Assessment Manual (Western Australian Department of Education, 1997). She noted that each tool had different skill criteria and used different assessment protocols (McIntyre, 2000). For example, the TGMD had 4 skill components, the Victorian package 6 components and the Western Australian package, 8 components. Mastery is evident if the component is demonstrated 2 out of 2 trials (TGMD), 4 out of 6 trials (Victorian Department of Education, 1996), or 3 out of 3 trials (Western Australian Department of Education, 1997). These differences prevent national comparisons between children.

Greater complexity in the wording and number of components in the records increases the potential for disagreement between observers, reduces reliability and the chances of being rated as proficient. The experience and skill level of the observer must also increase. However, the information gathered is more valuable. A compromise between complexity and depth of information and simplicity needs to be found. The NSW and Western Australian teacher resources provide several levels of observational complexity that assessors may choose according to their confidence in movement observation and purpose. These are the global check (overall the

movement looks proficient), components for initial focus (2 or 3 components only are observed) and finally components for fine-tuning (all the remaining components) and can be noted in Figure 1. Further research is needed to identify the optimum level of complexity and number of skill criteria to be included in the observation records as well as how many observations are necessary for maximum reliability.

How can observation records be interpreted?

Several approaches can be used to interpret information collected using observation records. The skill components not demonstrated could be individually reported for individuals or whole samples (McIntyre, 2000; Booth et al, 1997). Performers could be grouped based on a specified formula. The Fundamental Motor Skills- A Manual for Classroom teachers (Victorian Department of Education, 1996) suggests children are grouped based on the skill component they most need to practice. In the Western Australia Teacher Resource (EDWA, 2001), a 'rule of thumb' is recommended to categorise the performance of children on any one skill. Groupings based on this information facilitate the planning of learning experiences. Children are at the **beginning** level of achievement if they are unable to demonstrate any or only one of the skill criteria. They are at the **developing** level if they consistently demonstrate all of 2 or 3 initial focus criteria. A child at the **consolidating** level has mastered all or nearly all criteria and at the **generalising** level consistently demonstrates all skill criteria across a range of contexts. The Get Skilled Get Active Resource (NSW Department of Education and Training, 2000) suggests teachers use their professional judgement to identify children whose FMS performance is **progressing towards, achieved or working beyond** their expected level. Within the **progressing towards** category children could be identified as **beginning, developing or consolidating**. Finally, Walkey and colleagues (1993) and the NSW Schools Fitness and Physical Activity Survey (Booth et al., 1997) rated children as achieving **mastery** of a skill if all components were demonstrated or **near mastery** if only one component was not observed.

For all of these strategies, the impact of not taking into consideration the relative difficulty of a missing component is unknown. Performances rated as near mastery may vary significantly from child to child. For example, the overhand throw of a

child who is not demonstrating a hip-shoulder rotation is more proficient than that of a child who is not stepping forward. Miller (2002) found that performance variation was greater for some skill components both within and between children for the two handed sidearm strike.

W*hich skill components are easiest?*

For some FMS this information is available. The NSW Fitness and Physical Activity Survey (Booth et al., 1997) reported the percentage of each age group that demonstrated mastery of each component. For example, the percentage of 9-year-old boys who had mastered skill components of the overhand throw is shown in Figure 2. Most of the boys were focussing their eyes on the target, therefore this is the easiest component. On the other hand, very few boys showed a split hip-shoulder rotation, therefore this is the hardest component for them to master. McIntyre (2001) reported a similar pattern of component mastery for Western Australian children. Figure 3 reveals the percentage of mastery for each component of the throw among 7-year-old girls. In both studies, while the percentages varied a similar pattern of mastery was evident with this skill across all age groups studied.

A relatively new approach to psychometric measurement, the Rasch measurement model, is able to provide a different perspective when used to analyse FMS data. This technique, based on item response theory, is founded on the principles of fundamental measurement, order and objectivity (Wright, & Masters, 1982). Computer programs implementing this model (for example RUMM, (Andrich, Sheridan & Luo, 1997) test the fit of data to the model and position items and persons on a common unidimensional and additive scale. In the development of the Victorian FMS package, Walkley and colleagues used the Rasch measurement model to scale the difficulty level of individual skill components for a range of FMS with children aged between 6 and 12 years, shown in Figure 4 (Victorian Department of Education, 1996). The difficulty levels for the skill components of the overhand were similar to those reported by Booth et al (1997) and McIntyre (2000). The eyes focussed forward was very easy for the children in the study to demonstrate and the sequential hip and shoulder rotation was the hardest. The question now remains is how best to integrate this information into assessment tools. In the first instance, if the mastery of

components varies from the expected pattern it is highly likely that the child may have a motor learning disability and require additional support and intervention (Larkin & Hoare, 1991).

The relationship between qualitative and quantitative measures

Both qualitative and quantitative measures are useful when assessing FMS. In order to capture the inherent advantages of both approaches, some tests include both quantitative and qualitative test items. For example, I CAN Fundamental Skills (Wessel, 1976), comprises qualitative measures to assess children first learning a skill and product or outcome measures to assess the more proficient performers. The McCarron Assessment of Neuromuscular Development (McCarron, 1982) includes quantitative items, qualitative items and items that are measured using both approaches. The combination of approaches takes into account the more erratic and variable movement patterns of beginners compared to the more consistent patterns of skilled performers. With the latter group, quantitative measure better discriminate between performers. Consider, for example, the split second differences between 100 metre sprinters at the Olympic Games. The movement patterns are very similar but the outcomes differ.

Recent studies have compared qualitative and quantitative measures for the overarm throw (McIntyre, 2000; Roberton & Konczak, 2001) and the two handed strike (Miller, 2002). McIntyre (2000) reported a significant correlation of .754 ($p<.05$) between average distance thrown and quality of performance for children aged between 7 and 12 years. When calculated for each age groups, correlations ranged between .47 ($p = 0.14$) for 7-year-olds to .81 ($p<.00$) for 12-year-olds. These results suggest that as children become more proficient and more consistent in performance, the relationship between process and product becomes stronger (McIntyre, 2000). Roberton and Konszak (2001) also reported significant correlations between quantitative (ball velocity) and qualitative (skill components) measures for primary school aged children. They correlated different body components to the velocity and found correlations varied with age. For example, the trunk action correlations were low (between .1 and .3) until 13 years of age (.59) when stride length became more highly correlated (.71) and stepping dropped to .27 . Miller (2002) compared distance

weighted for accuracy and process measures for the two handed strike and found a significant relationship. She found younger boys (6- 7 years) were more proficient than the older girls (9-10 years) but the older girls were able to hit the ball further. This difference could be due height and weight advantages evident in the older girls. Overall, variability in performance was highest for children who were younger, female and with poorer coordination. These studies show that while the relationship between process and product is strong the interrelationships between body components and outcome change over time.

Assessment Issues

Several issues often surface with respect to FMS assessment: the age a child is expected to be proficient, the order skills should be assessed and taught, and the importance of gender differences. There are no easy answers to any of these issues. Children continue to astound researchers, professionals and parents with their capacity to master motor skills at early ages. We see very young children with proficient throwing styles and running patterns. Consequently, if we set an age expectancy or an age limit to motor skill mastery we may be disadvantaging some children. Secondly, while some skills are clearly easier than others there is no predetermined sequence of development. The first skills children usually practice and master are those of importance and interest to them and their peers. For example, in one community dribbling a soccer ball may be more important than dribbling a basketball or kicking a football. For some children, the hop is mastered earlier than the skip, whereas for other the skip is easier than the hop.

Significant gender differences are reported for many FMS (Thomas & French, 1985) and the extent these should be considered when assessing skills has been debated at length (Hands & Larkin, 1997; Wright, 1997). Using quantitative tasks such as overhand throw, sprint run and balance to compare FMS performances in 5 and 6 year old children, Hands (1997) used the Rasch measurement model to develop a FMS continuum of skill difficulty that differed for boys and girls (Hands, 1997). Boys found the overhand throw, catch (small and large ball) and kick much easier than girls, whereas girls found balance and skip much easier. These findings together with

the other reported differences suggest that FMS assessment approaches may need to vary for boys and girls.

Conclusion

Meaningful assessment methods that are practical and relevant to the performers are still evolving. In school settings, assessment should be an integral part of the teaching and learning process and undertaken during a number of different learning experiences. If assessment takes place away from a school setting, for example as part of a research study, the context and strategy choices may be more limited so that the process is standardised. In most instances, FMS assessment of young children is best undertaken using qualitative approaches and for each different context principles of assessment need to be considered. The process needs to be comprehensive, valid, explicit, educative and fair (Curriculum Council, 1998).

Comprehensive

Comprehensive assessment requires multiple types and sources of information. For example, a child's FMS performance could be observed in the playground, during a music session, during a physical activity session as well as during a formal assessment. In this way the assessor will be aware whether the child moves proficiently in both open and closed environments, when under pressure or when free to concentrate on the style, during free play or only during a PE class, when the outcome is important such as hitting a target. Children may demonstrate different levels of skill proficiency in settings that have different tasks, focuses, equipment and levels of competition. A second reason for assessing FMS performance over a number of occasions is to take into account intraindividual variability of performance. A child's pattern of movement, particularly in young children and those first learning a skill, may vary from trial to trial for the same task (Branta et al., 1984). This is taken into account in some assessment tools such as the Victorian Fundamental Motor Skill Manual where each component must be demonstrated in four out of five trials before being recorded as mastered.

While process evaluation using observation records is the most common approach to measure skill, additional information about children's knowledge, attitudes and values

with respect to FMS can be gathered using assessment techniques involving such as photographs, drawings, videotape, peer reflections and self-reflection techniques. Examples of many of these are described in the Fundamental Movement Skills Teacher Resource (Hands & Martin, 2001). Techniques that also gather information about the cognitive and affective aspects of FMS performance provide a more rounded picture of the child. For older children, that have mastered most aspects of skill performance, product based assessment may be more useful and challenging to the child. For example, the time to run 50 metres, the number of shuttle runs completed, or the distance a ball is thrown.

Valid

Valid assessment is undertaken when the child is involved in a relevant, meaningful and motivating activity that is in a familiar and comfortable environment. The activity is planned to enable the child an opportunity to demonstrate their mastery of the FMS. In this way, the assessor can be confident the best possible performance will be demonstrated. The performance criteria that are being observed should be based on a sound understanding of motor skill development.

Fair

Assessment is fair if the technique is inclusive and enables all children to use their strengths and interests. Gardner's (1983) work in multiple intelligences challenges us to structure assessment processes that provide children with the opportunity to use their strengths to demonstrate their abilities For example requiring children to write about a skill to demonstrate their knowledge about skill criteria may be a fair assessment for children who enjoy written work, whereas other children may prefer to demonstrate their knowledge orally, through artwork or music. Children with special needs may need additional support and encouragement to give their best performance.

Educative

The information gathered, where possible and appropriate, should be shared with the children in a way that positively contributes to their learning. This may be in the form of immediate verbal, visual or kinaesthetic feedback or may involve videotape or photographs. The actual assessment process itself when in a school setting should be an educational experience for the child.

Explicit

The criteria that are being assessed need to be clearly understood by the performer. Observation records, for example, are explicit about what is required for proficient performance. Children need to be fully informed on what they are being evaluated so there is a greater likelihood they will perform at their highest level.

In conclusion, further research is necessary to clarify many of the issues surrounding the assessment of FMS in children. It is clear, however that authentic assessment approaches are more likely to provide truer pictures of children's abilities. By de-emphasising formal testing in an isolated context, FMS assessment as an integral part of any school or community based movement program will develop more desirable testing practices and better informed teaching and learning programs.

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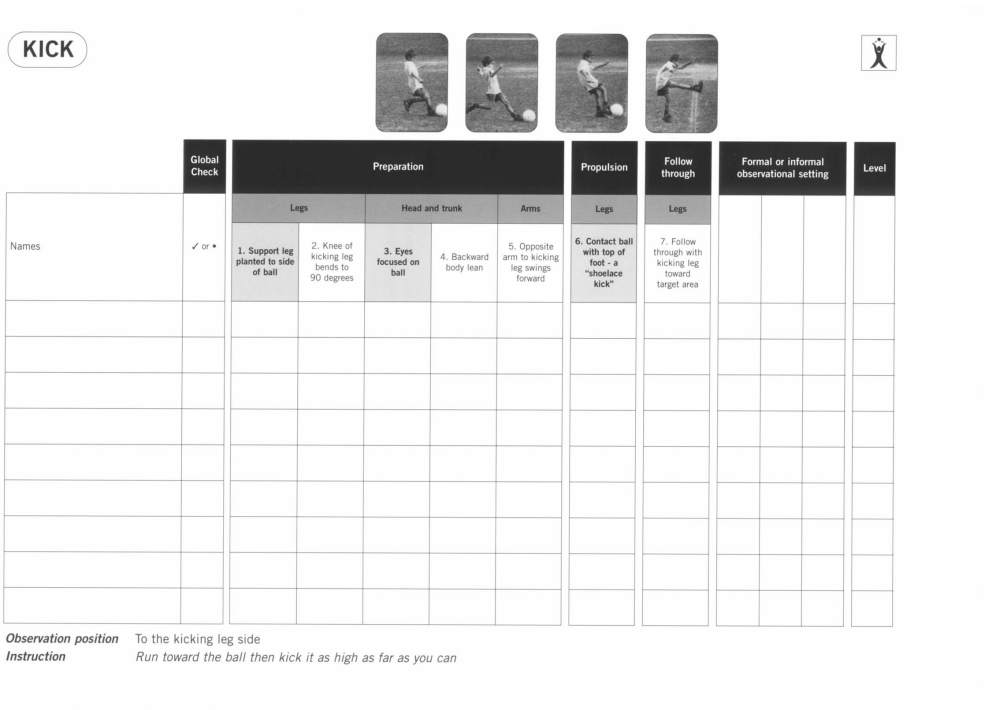

KICK

Names	Global Check	Preparation					Propulsion	Follow through	Formal or informal observational setting			Level
		Legs		Head and trunk		Arms	Legs	Legs				
	✓ or •	1. Support leg planted to side of ball	2. Knee of kicking leg bends to 90 degrees	3. Eyes focused on ball	4. Backward body lean	5. Opposite arm to kicking leg swings forward	6. Contact ball with top of foot - a "shoelace kick"	7. Follow through with kicking leg toward target area				

Observation position To the kicking leg side
Instruction *Run toward the ball then kick it as high as far as you can*

Figure 1. Observation record for Kick (Education Department of Education, 2001)

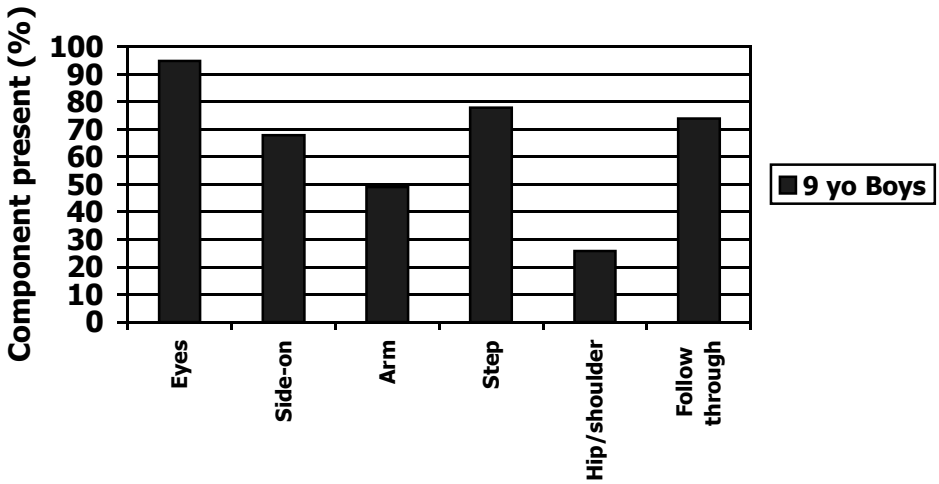

Figure 2. Percentage of 9-year-old boys demonstrating mastery of components of the overhand throw (adapted from Booth et al., 1997)

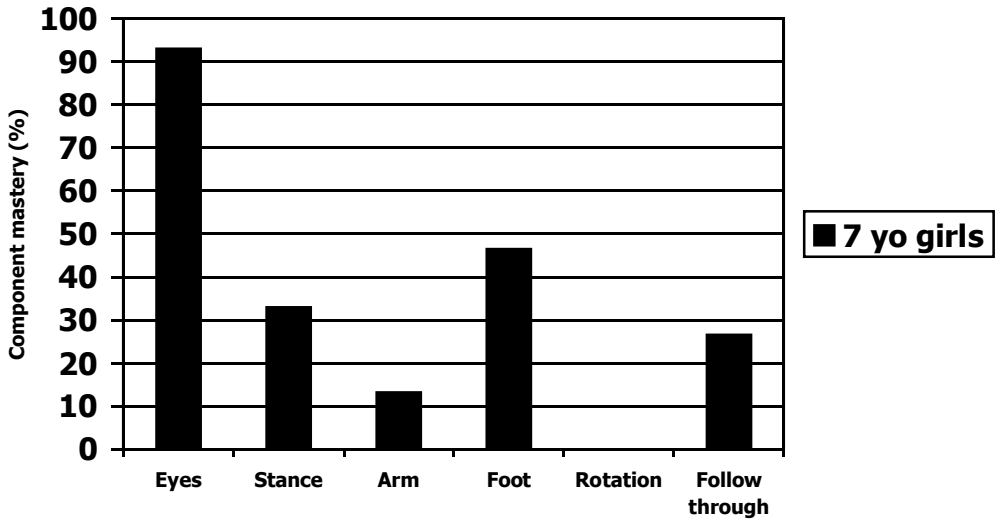

Figure 3. Percentage of 7-year-old girls demonstrating mastery of components of the overhand throw (McIntyre, 2000)

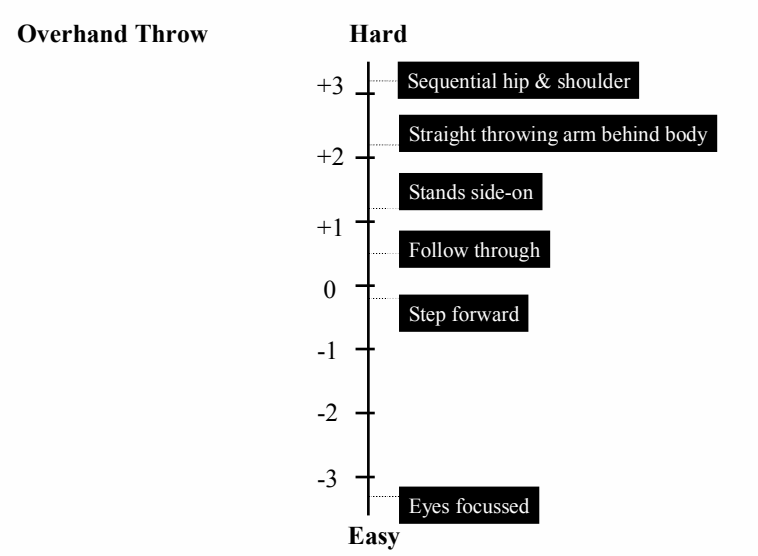

Figure 4. Difficulty continuum for skill components of the overhand throw. Modified from Victorian Department of Education (1996) *Fundamental Motor Skills: A classroom manual for teachers.*

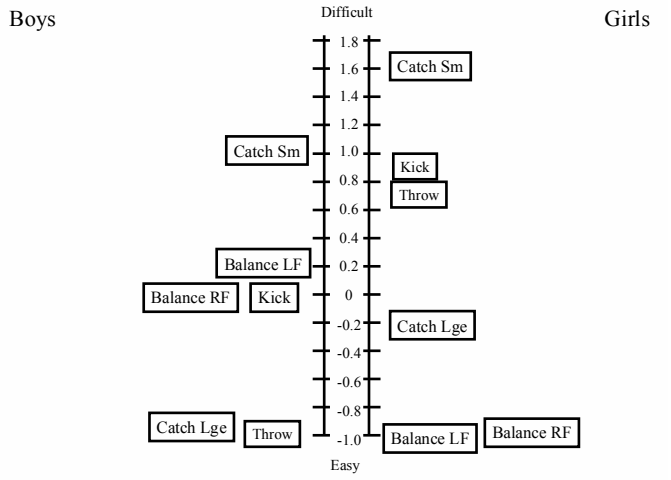

Figure 5. Continuum of skill difficulty for 5- and 6-year-old boys (left) and girls (right) (Hands, 1997).