

Fundamental Motor Skill Intervention Programs: Improving Performance?

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by

Judith Miller and Scott Dickson

School of Curriculum Studies, University of New England

ABSTRACT

Fundamental motor skill proficiency has been linked to continued participation in sporting activity. However, a number of investigations in Australia have reported inferior levels of the process performance of skills such as kicking, throwing, striking, and catching. Recommendations emanating from the recent NSW Fitness and Physical Activity Survey included greater attention to preparing generalist teachers at the tertiary level. The logical assumption being this will translate into better instruction, and therefore greater proficiency, in fundamental motor skills of primary aged children. This paper reports on the efficacy of an intervention designed to improve the process forms of the fundamental motor skills, of the overhand throw. A five week intensive instruction program for nine and ten year old boys and girls ($n=70$) was implemented at an urban school to improve the performance of the overhand throw. The Victorian Fundamental Motor Skills manual instrument was employed for assessing the 'process' forms of the skill. Data were analysed using Rasch and Multivariate techniques. Group means evidenced improvement, and trends of improvement within gender groups were unique, however, no significant differences ($p=.05$) were found attributable to the intervention. The results are viewed in terms of improving skill levels in the primary school setting through the accepted four to five week physical education unit.

Introduction

In recent years, the performance levels of fundamental motor skills for children have attracted major attention in Australia. In particular, the Australian Senate Inquiry into Physical and Sport Education (1992) and the Review of Physical Education in Western Australian Schools (1994) reported inadequate proficiency levels of fundamental motor skills for primary aged children. Similarly, statewide research in Victoria (Walkley, Holland, Rose, Treloar & Probynsmith, 1993) reported high failure rate of boys (50%) and girls (up to 75%) in reaching a mature form of various fundamental motor skills. Studies in the Hunter region of New South Wales (Thompson, McCormack, Thomas, & Woodcock, 1995) and more recently, the NSW Schools Fitness and Physical Activity Survey (Booth, Macaskill, Phongsavan, Okeley, Patterson, Wright, Bauman, & Baur, 1997) reinforced these findings, thus suggesting that the poor levels of proficiency in fundamental skills is not a problem only in Western Australia or Victoria, but is widespread throughout Australia.

Overall, these studies concluded that children's quality of performance, on a range of fundamental motor skills was substantially lower than could reasonably be expected for their chronological age or range of physical development. Understandably, these findings alarmed physical educators because they suggest there is a high failure rate in developing the physical potential of children with long-term, deleterious implications for national health and future participation in sport.

Proficiency in fundamental motor skills is regarded as essential for future participation in sports and physical activity (Gallahue & Ozmun, 1995), and is central to the physical competence of children (Rose, 1994). Indirectly, the perceived lack of competence in fundamental motor skills is seen as a barrier to future participation in sport and physical activities for primary aged children (Seefeldt 1989) and for adolescents (Clough, 1993; Senate Standing Committee on the Environment, 1992). Diminished physical competence leads to being the 'last ones chosen' for games in the playground (Larkin & Hoare, 1991), and, conversely, physical competence is linked to high levels of social esteem and frequent participation in sport and a wide range of physical activities (Rose, 1994). The link between

competence in motor skills and participation in sports and physical activity, indicates the critical nature of fundamental motor skill proficiency.

The centrality of competence in fundamental skills, and the subsequent participation in sport specific skills, is recognised in the guiding aims of Personal Development Health and Physical Education (PDHPE) curriculum for primary aged children. The lifelong participation in sports and physical activity is one of three aim(s) of the K-6 Personal Development Health and Physical Education syllabus in New South Wales schools. The guiding principles of primary physical education at the curriculum level recognises the benefits of participation in sports includes health related fitness (physical health) and increased feelings of wellbeing, enhanced social interaction, and consequential improvements in social esteem.

Given these issues, fundamental motor skill proficiency can be seen as a necessary precondition for long-term participation in sport and physical activity. The lack of these skills is a precursor to withdrawal from physical activity with a corresponding deleterious effects on physical, mental and social well-being. As alarming as these consequences are for primary-aged children, they are worse for girls.

Girls and boys have been reported to perform at disparate levels of performance across the range of fundamental motor skills. Generally, boys have outperformed girls in skill items requiring strength, but girls have equalled or surpassed boys performances in skill items requiring balance, rhythm and some locomotion activities (Hands & Larkin, 1997). In order to understand the underlying causes of the disparity in performance, both physical and social factors have been suggested. Although sex (physiological) characteristics account for some differences in motor skill performances that require strength (Corbin, 1980; Thomas & French, 1985), social conditioning, or culturalisation now appears to be the predominant underlying cause of disparity in performance of motor skills (Greendorfer & Brundage, 1985). However, the interaction of both factors (biological and cultural/environmental) are more likely to account for the disparity in performance (Hands & Larkin, 1997; Wright 1997). Given the disparity in performance between boys and girls and the overall inadequate performance of primary aged children, remediation of some form is needed.

In order to find appropriate forms of remediation, attention was turned to the recommendations from the most recent statewide surveys of fundamental motor skill proficiency (Booth et al., 1997). The recommendations included additional hours of instruction in tertiary teaching preparation courses. The assumption appears to be that if teachers are better prepared to teach fundamental motor skills, then this will translate to higher performance levels of fundamental motor skills in the children. This logical assumption has emerged from the Senate Inquiry (1992), Walkley et al., (1993) Booth et al., (1997), and raises the need to test the efficacy of providing additional instruction to a group of primary aged children. Additionally, given the teaching within the primary school context 'typically' involves units of work that span up to five weeks duration, it was appropriate to model the intervention content and duration in terms of what occurs in the school context.

In view of the recommendations, this paper reports on a study designed to test the efficacy of providing a five week fundamental motor skill intervention at an urban primary school. Specifically, the intervention focused on improving the performance of the fundamental motor skill of the overarm throw.

Method

Research Design

An experimental research design was employed. The sample was pretested on the process measures of the overhand throw. Treatment consisted of five weeks of fundamental movement skill instruction. Posttest of the process measures of performance were compared to the pretest for effects of intervention and gender.

Sample

Children were included in this study on the basis of parental permission. The sample ($n=70$) included 35 males and 35 females selected from an urban school in New South Wales. There were 30 nine-year-olds (14 males & 16 females) and 40 ten-year-olds (21 males & 19 females). This age range was targeted for this research due to the consistent expectation in terms of the literature, that children at the age of nine are capable of 'mastery' standards in all fundamental motor skills (Kelly et al., 1989; Walkley et al., 1993).

Procedures

Students were initially assessed (pretest) to establish process standards of proficiency for the overhand throw. All testing procedures were conducted within a school playground setting. The ball was a standard softball with cushioning to make the ball easier to grip and handle. The children were provided with two practice trials to become comfortable with the testing environment. They were then asked to throw "as far as they could towards the target" and the landing place was recorded for the distance or product measure of the throw. The three trials were video-taped to facilitate qualitative process analysis. Product measures of distance and accuracy were recorded but will not be presented in this paper.

The Process Instrument for Overarm Throw

The Victorian Fundamental Motor Skills assessment criteria (1996) was the most appropriate instrument for this investigation as it is a recognised test and has previously been used within the Australian context. This instrument was used concurrently for the N.S.W. Schools Fitness and Physical Activity Survey (Booth et al., 1997). The instrument was used initially in Michigan (Kelley et al., 1989; Holland 1986), and the adoption by state wide studies provides a contextual reference to facilitate the comparisons across states and cultures.

Frame by frame video analysis was completed using the component criteria provided by the Victorian Department of Education (1996). The six criteria representing 'mastery' standard for the overarm throw are:

Criteria 1) Eyes are focused on the target throughout the throw;

Criteria 2) Stand side-on to the target;

Criteria 3) Throwing arm nearly straightened behind the body;

Criteria 4) Step towards the target with foot opposite throwing arm during throw;

Criteria 5) Marked sequential hip to shoulder rotation during the throw; and

Criteria 6) Throwing arm follows through down and across the body.

Each individual throw was given a score in accordance with a dichotomous scale which indicated the presence or absence of each of the six criteria. This procedure was repeated six times (3 pretest trials and 3 posttest trials) for each subject. A pragmatic decision to take the third trial was made and therefore the pretest and posttest scores are those from the third trial.

Intervention

The five week intervention was aimed at improving the process performance of the overarm throw. The intervention was designed to represent a 'typical' unit of work i.e., comprising five weeks of one sixty-minute lesson per week. The allocation is the weekly 'recommended' time from the draft K-6 PDHPE syllabus (1992). In total, the intervention represented five hours of instruction and guided practise.

The teaching content of the intervention included the activities and methodologies designed to increase proficiency in the overarm throw. The criteria for mastery standards of the overarm throw were used as teaching cues throughout the intervention. The teaching activities included using a variety of equipment such as bean bags, soft foam balls, tennis balls and softballs. Throwing at targets such as hoops, throwing for distance, and throwing to a partner, were all included as substantive activities. The teaching methods included the visualisation of the correct or most efficient form of overarm throwing technique, throwing for distance, and throwing for accuracy. The Victorian Fundamental Motor Skill manual, and activities suggested by the NSW K-6 PDHPE Syllabus, were references for the intervention content and methodology. In summary, the intervention included a total of five hours of guided instruction and practise designed specifically to improve the performance of the overarm throw. The content and strategies reflected a 'typical unit of work' designed to improve skill levels within a primary school context.

Analysis

The data were analysed using two techniques. Firstly, process scores were analysed using Rasch Latent Trait Scaling techniques. In the context of this study, Rasch scaling provides two important analytical procedures. These include: assessing the suitability of data to model (i.e., the homogeneity of data); and, the 'conversion' of ordinal scores to interval level measures. This latter procedure produces 'item' and 'case' estimates appropriate for additional multivariate analysis. Secondly, MANOVA techniques were employed (using item and case estimates) to detect significant interactions between the treatment (independent variables) and the process scores comparing the pretest and posttest measures (dependent variables).

Results

Results from this study comprise two sections. The first section reports findings of Rasch scaling, while the second reviews MANOVA findings pertaining to interaction effects of process measures for intervention and gender.

Rasch Results

Rasch fit statistics indicated the data has a good fit to the model (infit mean square close to 1, and infit t close to 0) for all trials. Item estimate reliability measures ranging from .86 - .91 indicated components within each trail were stable and sufficiently separated to give meaning to the results. However, the low reliability of case estimates (0 - .10) indicates there is poor separation between the cases (students). A summary of these results is provided in Table 1.

Table 1: Summary of Rasch Analysis Results.

	Trial Number	Number of Components that fit the model	Reliability item estimate	Reliability case estimate
	Trial 1	6/6	.86	.10
Pre-test	Trial 2	5/6	.87	.00
	Trial 3	6/6	.89	.00
	Trial 1	6/6	.91	.00
Post-test	Trial 2	6/6	.90	.00
	Trial 3	6/6	.90	.00

Item fit maps, produced in conjunction with the fit statistics, showed all components were related to the skill under investigation in five of the six trials. The exception to the trend was pretest trial 2. This trial presented one misfitting component. Closer inspection of findings revealed this to be 'marked sequential hip to shoulder rotation.' Reasons attributed to this misfit are two-fold. Firstly, it could be the case that for this trial, the criteria was too difficult for the performers, or, secondly, they failed to have the same alignment of success at the component level for the process performance. However, notwithstanding this item, the results provide additional verification of the Victorian Fundamental Motor Skill Manual.

Case estimate reliabilities, provided in Table 1, are low. This indicates poor separation between the subjects. It is surmised that the homogeneous sample, in terms of skill level and age (9-10 years) contributed markedly to this result. Such low estimates necessitated the computation of a new process measure based on a weighted algorithm derived from item estimates.

Multivariate Results

To ascertain the levels of significant differences from pretest to posttest, a doubly multivariate MANOVA was employed. The results indicated no significant differences for Intervention x Gender x Time ($p = 0.5232$). As there as no significant difference for Time (repeat measure pretest to posttest), an ANOVA was then implemented in order to look for any effects not implicated by Time. Investigating the effect for treatment with the dependant variable of Process, a main effect was evidence for Gender ($p = 0.0002$). The implication of this result is that regardless of treatment, males outperformed females on the process of the overarm throw.

Group Measures

Further to multivariate techniques, there is value in viewing the group measures at the criteria level, to investigate those criteria that are most implicated in causing the significant gender difference. Pretest gender differences are evident in each criteria (see Figure 1). The order of each criteria presented in Figure 1 reflects the developmental sequence as outlined by the Victorian Fundamental Motor Skill Manual (1996, p. 24). Criteria one is expected to be mastered by the age of five, followed by criteria four and six by the age of seven, criteria two and three by the age of eight and criteria five by the age of nine.

The gender differences for each component criteria were subjected to a two-tailed *t*-test to ascertain levels of significant differences. Following are the gender results for each criteria with group means and associated *t*-test results.

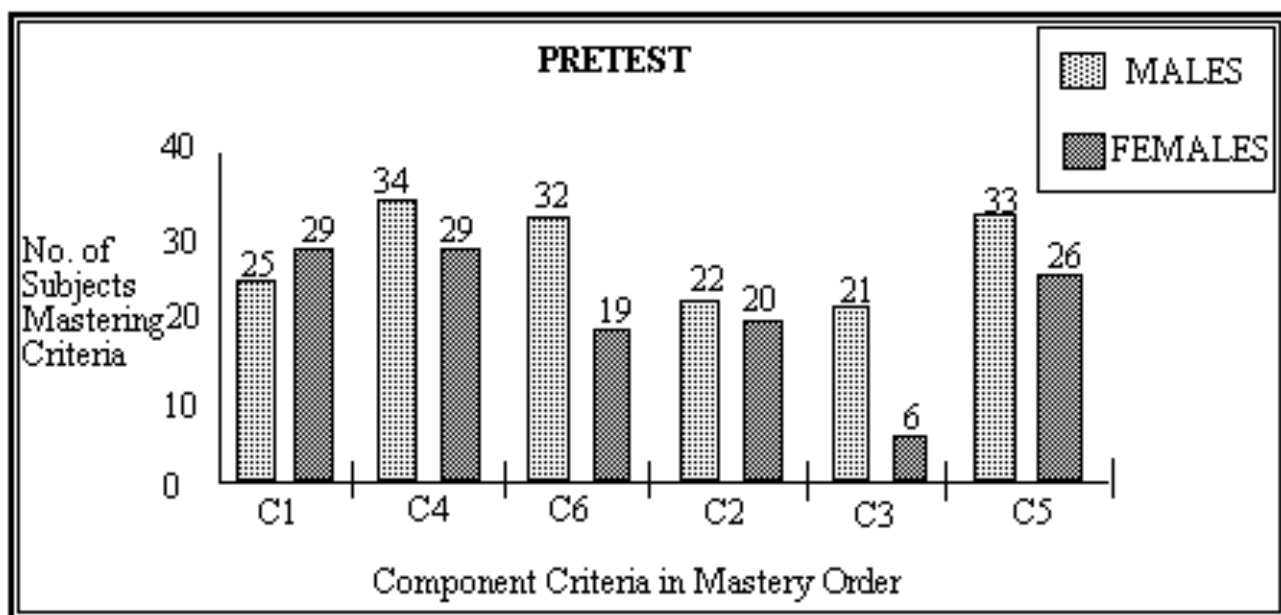


Figure 1: Gender Differences in Pretest Criteria Mastery of the Overarm Throw.

Criteria 1 : Eyes are focused on the target throughout the throw

This criteria resulted in 25 boys (71%) as opposed to 29 girls (83%) executing mastery of this component. This is the only criteria in which females outperformed the male subjects. There was no significant difference ($p = 0.75$) in performance attributable to gender.

Criteria 4 : Step towards the target with foot opposite throwing arm during the throw

Criteria four evidenced 34 boys (97%) compared to 29 girls (83%) exhibiting mastery of stepping towards the target with the appropriate foot. There was a significant gender difference ($p = 0.02$) for this criteria.

Criteria 6 : Throwing arm follows through down and across the body

Differences in the follow through of the overarm throw occurred in that 32 boys (91%) as opposed to 19 girls (54%) mastered this criteria. A significant gender difference ($p = <.001$) is evident.

Criteria 2 : Stand side-on to the target

A smaller difference was found in this criteria as 22 boys (63%) compared to 20 girls (57%) stood side-on to the target. This criteria represents the least discrepancy between males and females in pretesting. There is no significant gender difference ($p = 0.8$) for this criteria.

Criteria 3: Throwing arm nearly straightened behind the body

Criteria three posed the largest gender difference with 21 boys (60%) performing at the mastery level as opposed to 6 girls (17%). This criteria exhibited the greatest difference between sexes. There is a significant gender difference ($p = 0.001$) for this criteria.

Criteria 5: Marked sequential hip to shoulder rotation during the throw

This criteria represents success for 33 boys (94%) whereas 26 girls (74%) executed mastery of this criteria. This criteria evidenced a significant gender difference ($p= 0.02$).

In summary, results indicated males outperformed females on a four of the six criteria. Four of the six criteria evidenced a significant difference in performance comparing boys and girls. The criteria that failed to evidence a significant gender difference is criteria one and two. Therefore, 'keeping eyes on the target' tended to have a ceiling effect and 'standing side on to the target' had approximately the same number of boys as girls evidencing mastery standard of performance for this criteria.

Comparisons on the pretest measures in terms of gender have been presented, and lacking a significant effect from pretest to posttest attributable to the intervention, there is benefit in viewing changes at the criteria level for males and females. It may be the case that there are many changes across the intervention period that cancel each other out in aggregating group performance. There is value in viewing the net difference in the performance at the component level for both groups, across the five week intervention period. Table 2 provides such a gender comparison, by criteria, showing the net change from pretest to posttest.

Table 2: Gender Comparisons of net changes from pretest to posttest by components of the overarm throw ($n=70$).

Component Description of the Overarm Throw	Males	Females	Age of 'mastery'
C1: eyes focused on the target throughout the throw	-11	-3	5 years
C4: step toward target with foot opposite throwing arm during the throw	-2	1	7 years
C6: throwing arm follows through down and across the body	-2	8	7 years
C2: stand side-on to the target	13	13	8 years
C3: throwing arm nearly straightened behind the body	6	1	8 years
C5: marked sequential hip to shoulder	1	4	9 years

rotation during the throw			
Net change per group (males & females)	+5	+24	

In Table 2, the net change in component mastery, for each gender, is presented in order of mastery. As noted previously, the expected 'age of component mastery' is also included and is presented in view of the sample being nine or ten years of age (Victorian Department of Education, 1996). Standing side on to the target evidenced an increase of the greatest magnitude (13 boys and 13 girls) therefore there is greater mastery in this component across the intervention period. This result may be attributable to this component being within the preparatory phase of the skill, and therefore, it may be easier for the children to attend to this component of the skill without losing efficiency or mastery in other components. Component two evidenced the greatest change and consistently for males and females. Notably, the boys displayed the greatest negative net changes per component (i.e., fewer children evidenced mastery levels) and, moreover, are evidenced in components that were expected to be consolidated. Component one is an excellent example of this occurrence. Eleven boys failed to keep their eyes focused on the target throughout the posttest throw, having previously being coded as 'mastery' for this component in the pretest. Similarly, three girls demonstrated a decrease for component one. Anecdotally, the coder noted that the children attended to the more 'difficult' criteria in the posttest e.g., turning their head to see if their arm was straight (component three). Not surprisingly, there is a net *increase* in the number of children mastering this component (6 boys and 1 girl). However, in attending to the position of their arm, the children failed to demonstrate component one.

In interpreting the overall net changes, the following trends emerge, Firstly, with focused instruction, children are attending to more difficult components of the skill, (evidenced with positive net changes in components two, three, and five) resulting in changes to the integrative capacity of the performers. Secondly, children failed to demonstrate the components previously 'consolidated' such as criteria one, four and six as they mastered more difficult components of the skill.

Thirdly, boys decreased their performance in components 1, 4 and 6. Increases in component 2, 3 and 5 brought overall net change to +5 for boys. The trends are very different for the females. They had a consistent positive net gain in their performance of +24. The only exception to this trend is the three girls who failed to demonstrate 'eyes focused on the target throughout the strike', however, all other components had increases in the number of girls performing at the mastery level. This gender comparison is rich in implications. It would appear that the boys, in trying to master the more difficult components, lost the stability in performance at the easier component level, however, the girls increased their performance on all but the first component. This interpretation of finding should be contextualised that the girls were at a lower baseline level of mastery, and therefore they increased their performance for the majority of the skill components. This may be a reflection of the learning process at the less skilled end of the continuum or it may be a 'female style' of learning. Conversely, the boys were at a higher level of performance for pretesting, and therefore, had less potential for gains. In attempting to consolidate the more difficult components of the skill, there was change in the consolidation of the 'easier' components which may be a reflection of the learning process at the more skilled end of the continuum or it may be a 'male style' of learning.

In summary the results have provided a wholistic picture of the degree to which the data fits the model, confirmation of the difficult items to master, lack of significant interaction at the MANOVA level, however, there is an effect for gender which is detailed through pretest component comparisons by gender and the net change at the mean level for boys and girls

across the intervention period. Boys perform at a higher pretest level, however, girls evidenced the greatest gain from the intervention period with the greatest positive gain in the mastery standards for the components of the overarm throw.

Conclusion

This study investigated the efficacy of additional instruction in terms of an intervention. The purpose of the intervention was to improve the process performance of the overarm throw for 9-10 year old children. The intervention of instruction to improve the overarm throw, replicates the standard unit plan of five weeks duration. This unit was designed to improve the skill development within the school setting. There was no significant differences in the performance attributable to the intervention. There was a significant effect for gender confirming the boys outperform girls in the pretest measures. Subsequently, analysis of gender differences in performance on pretest scores showed a significant difference for gender was evident in four of the six components/criteria of the overarm throw. This result confirmed that prior to any form of instruction there are significant differences between the boys and girls in their mastery level of the overarm throw.

Although a significant effect for intervention was not apparent in this study, previous studies have reported a significant change in process performances of the overarm throw attributable to increased instruction (Robertson, 1978; Halverson & Robertson, 1979; Leudke, 1980; and Burton, Greer & Wiese-Bjornstal, 1993). However, it is important to keep in mind when comparing this current research with previous studies that the component approach to measure the process of the skill was adopted for the more 'successful studies'. The component approach is a finer grained instrument that allows for detection of minor changes at the segmental level, and is capable of detecting minor variations of performance within the four stages of the overarm throw. This is contrasted with the Victorian instrument (1996) which provided an instrument that is a dichotomous assessment of the most efficient form of the skill. Therefore, the component instrument is more sensitive and descriptive in terms of the gradual change from inefficient to efficient performance at a segmental level. However, the dichotomous instrument indicates if the performer has reached the highest level of efficiency. Therefore, in comparing studies that aim to measure the effect of intervention, it would seem to be crucial to view these results in terms of the degree to which the process instrument can detect fine or gross changes in performance.

The significant effect for gender for the pretest and the group measures provided a picture of improved skill level over the intervention period with girls outperforming boys in net gains at the process level of performance. It is important to interpret these results from a long-term versus a short-term perspective. It is evident from this research that there are no 'quick fixes' to the inadequate levels of fundamental motor skill proficiency for our primary aged children. However, it is encouraging that the girls are benefiting to a greater degree than the boys from intensive instructional programs. The improvement of the girls skill level must be considered within the context of the girls beginning the intervention with a lower baseline level of performance. Therefore, although as a total group, the intervention did not prove to increase performance in a statistical significant manner, the general trends of improvement are encouraging enough to continue addressing efficiency levels of skills such as the overarm throw. The changes in future intervention may explore the manipulation of the variables pertaining to the intervention, such as employing different content, methodologies and increased instruction time. Alternatively, an exploration of the instrument to measure levels of efficiency may prove to be beneficial in providing a deeper understanding of the stability of performance within varying levels of skilled performers.

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