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Where is Armidale?
University of New England
Hot Topic

- Motor Ability and Skill Acquisition: Interrelationships between primary school-aged students and teachers practice.
Introduction

- Motor Ability – coordination – Neuromuscular Development Index (NDI)
- Fundamental motor skill performances (FMS)
- Investigating the relationship between coordination (motor ability) and performances of the two handed sidearm strike.
Background

• Coordination – efficient (lack of extraneous movements), to inefficient (awkwardness – DCD clumsiness), full spectrum

• Skill levels below the expectations – Michigan (USA) Haubenstricker, Seefeldt 1990; (Vic & NSW) Walkley et al., 1993, Booth et al., 1997.

• Skilled Movement – what accounts for performance on the continuum of skilled to unskilled?
Coordination and skill

• “In the performance of a movement task, even where the criterion of success is solely an outcome measure and skill level is defined by the outcome of an action, skill level is also a function of the patterns of movement coordination” (Broderick & Newell 1999: 165).
Gallahue’s Model of Motor Development (1989)

**THE STAGES OF MOTOR DEVELOPMENT.**

- **Reflexive Movement Phase**
  - In Utero to 4 months old
  - 4 months to 1 year old
  - Birth to 1 year old

- **Rudimentary Movement Phase**
  - 1 to 2 years old
  - 2 to 3 years old
  - 4 to 5 years old
  - 6 to 7 years old

- **Fundamental Movement Phase**
  - 7 to 10 years old
  - 11 to 13 years old

- **Specialised Movement Phase**
  - 14 years old and up

**APPROXIMATE AGE PERIODS OF DEVELOPMENT**

- Lifelong utilisation stage
  - Lifelong competitive utilisation

- Application stage
  - Transition stage

- Mature stage
  - Elementary stage
  - Initial stage

- Precontrol stage
  - Reflex inhibition stage

- Information decoding stage
  - Information encoding stage
Importance of this topic

• Fundamental Motor Skills – large scale studies (Michigan, Australian states, UK? Japan? ) etc.

• Educational Push for FMS proficiency

• Intersecting domains of special education (DCD); pedagogy of pre-service teacher education (primary); and what are our ‘expectations’ of primary school-aged children?

• Is it Hot?... Ask an expert! I did.
Ask the expert

- After extensive literature searches, I still did not know: What was the empirical evidence to support the expectation that all children aged 9 should be proficient (mature) in FMS.

- Prof. John Haubenstricker: “Children have physiological readiness by age 9 and FMS must be taught or caught”

- And, if researchers had investigated the relationship between Coordination levels and FMS?

- Dr Dawn Larkin (UWA): “No – it is a great idea!”
Theoretical basis

• At present, there is no commonly accepted, comprehensive theory of motor development, influenced by the fact that most of the research has been largely descriptive in nature. Description has led to an accumulation of facts and the generation of principles, but has not stimulated a formulation of theories that explain the behaviour observed. (Haubenstricker & Seefeldt, 1986, pp. 43-44)

• Dynamic Systems theory framed, supported and directed this study
DST has three key concepts.

• Firstly, the body is comprised of multiple systems. These systems are self-organising and can spontaneously form patterns that arise solely from the interaction of the component parts (Thelen, 1989b; Thelen & Ulrich, 1991).

• Secondly, the body’s systems and subsystems self-organise in a complex and cooperative response to task demands and the environmental affordances or perturbances.

• Thirdly, the development of the body is of a discontinuous nature with new movement patterns replacing old ones.
Research Questions

Performer: Age and Gender

• The first issue is related to the effect of age on the performance of the strike for both process and product performance of primary school-aged children within a task of a fundamental motor skill, such as the strike.

• What changes in performance can be attributable to the effect of age (six-to-ten year olds)?

• Additionally, what is the effect of gender on product and process performance of the strike.
Coordination and Age.

Performer

Coordination

• The second issue centres on the role coordination plays in product and process performance of the strike. This issue is concerned with the role of motor ability expressed as coordination, and the specific task performance of the strike.

Age

• Additionally, the issue of the stability of the six-to-ten year old children’s coordination across the primary ages provides a further understanding of the attributes of the primary school-aged performer.
Performance Measures

Product and Process

• The third issue relates to measurement of skills and seeks to determine the relationship between product and process measures of performance.

• Performance has not previously been viewed in terms of both process (i.e., levels of efficiency) and product (i.e., distance and accuracy) and it represents a key theoretical measurement issue to explore the nature of such an association or relationship.
Variability of Process

Variability

- The fourth issue is concerned with variability of performance of the strike. The degree of change at the process level for children grouped for age, sex and coordination level has potential to advance our understandings of the nature of skilled or unskilled performances.
Conceptual Framework
Research Design

• Cross sectional – quasi experimental
• Mixed Method
  (quantitative/qualitative)

• Participants \( (n = 161) \)
• Instruments
  - McCarron Assessment of Neuromuscular Development MAND
    (McCarron, 1997)
  - Video (process)
  - Measure distance (product)
  - BMI
Participants involved in the study:

- 161 students - principal study
- \( n=34 \) boys and 31 girls (6-7 yrs) total 65
- \( n=41 \) boys and 55 girls (9-10 yrs) total 96
- total = 75 boys and 86 girls

Principal study cohort had a normal distribution of NDI scores...

Which was a positive in approach to a pilot study for the process instrument
Instruments

• McCarron Assessment of Neuromuscular Development (MAND) (McCarron, 1997).
• Amalgamated Striking Instrument.
• Measurements taken in an ‘ecologically valid environment’.
MAND (McCarron 1997)

- Ten tasks
- Fine and gross motor tasks
- Beads in the box, *beads on the rod, nut & bolt, rod slide, jump, heel and toe, *standing on one foot, hand strength, finger tap, *finger/nose (*eyes open/eyes closed).
- Quantitative and qualitative measures
- Age-normed
- 100 Mean SD=15
- Used extensively to identify childrens motor ability and Developmental Coordination Disorder (DCD)

- Ethical issues arise here: children identified as DCD and professional and ethical responsibility to ensure they are provided with remediation.
Amalgamated Process Instrument

- Total Body Configurations (TBC)
- Component Approach (CA)

- Trialing the use of these instruments to provide a theoretically robust instrument and a process of ‘validation’ of the items.

- Piloted 7 versions of the strike (hand/paddle/bat) x (ball type) x stationary, moving, ball stationary x ball moving. NDI/ZMAND and Rasch. *Highly recommend pilot procedures and instruments.
Total Body Configuration (TBC)

• Three stages of the skill of striking (TBC)

  (Gallahue & Ozmun 1998:258)
Examples of qualitative components used to measure Fundamental skills such as the forehand strike (Component Approach)

• 1. Eyes focused on the ball throughout strike
• 2. Stand side-on to target with bat held in one hand
• 3. Striking arm nearly straightened behind shoulder at end of swing
• 4. Step toward the target with foot opposite striking arm during strike
• 5. Marked sequential hip to shoulder rotation during strike
• 6. Ball contact made opposite front foot with straight arm
• 7. Follow through toward the target then around the body.
Process is assessed using...

- A new ‘amalgamated process instrument’
- Ten components
- Three levels within each component
- Derived from total body configuration (TBC), and...
- Component Approach (CA)

For 6 trials
Video taped and each person coded for one of three levels for all ten components (6 trials x 10 components x 161 participants)
3 levels on each of the following 10 components:

1: Preparatory bat position – on shoulder – off shoulder – or at the tee
2: Legs being straight, flexed, or with weight transfer
3: Trunk position with varying positions, from facing the target to side-on
4: Eyes following the ball, partially, or not at all
5: Backswing using three distinct degrees with the bat
6: Arm motion during the striking phase during contact with the ball
7: Grip on the bat with relative hand placement
8: Contact, under or over hit the ball or air-swing
9: Arm motion angle during follow through phase
10: Trunk rotation to marked sequential hip and shoulder rotation
Figure 1: The Accuracy Weighted Distance Measurement Batting V
Data Analysis Plan

Figure 4.4: Data Analysis Plan for Principal Study (Part I)
Rasch Model ACER’s Quest Analysis Output

Allowed for the ‘amalgamated process’ instrument to be validated in terms of a single underlying construct ie., ‘levels of efficiency.’

Item Fit, Case Estimates, Item Difficulty

Takes ordinal observations and transforms them to interval measures. This then allows for subsequent comparisons with other interval data. Logits are a measure of process for our purposes.
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<th>INFIT</th>
<th>MNSQ</th>
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<th>.63</th>
<th>.77</th>
<th>1.00</th>
<th>1.30</th>
<th>1.60</th>
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Figure 2: Item Fit for 10 Components For Group Two (n=161)
Figure 3: Item Threshold Map for Group Two
## Results

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<tr>
<th></th>
<th>Process (logits)</th>
<th>Product (metres)</th>
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<tbody>
<tr>
<td>9-10 Boys ($n=41$)</td>
<td>3.13</td>
<td>22.77</td>
</tr>
<tr>
<td>9-10 Girls ($n=55$)</td>
<td>1.50</td>
<td>15.14</td>
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<tr>
<td>6-7 Boys ($n=34$)</td>
<td>1.83</td>
<td>13.21</td>
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<tr>
<td>6-7 Girls ($n=31$)</td>
<td>-0.13</td>
<td>5.93</td>
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<tr>
<td>Girls ($n=86$)</td>
<td>1.37</td>
<td>10.54</td>
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<tr>
<td>Boys ($n=75$)</td>
<td>4.96</td>
<td>17.99</td>
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Further Exploration of Age and Gender Effects

- There was no significant two-way interaction found between age and sex, indicating consistency of performance across both levels of both factors.
- For the process variable, the younger boys outperformed both the younger and older girls. On that basis it might have been expected that the younger boys would also have outperformed both the younger and older girls in respect of the distance measure.
- This was investigated by carrying out a 2-tailed $t$ test with height and weight as independent variables, and age and sex as dependent variables.
- The boys were lighter (23.8 kg average) compared to the older girls (34.8 kg) and shorter (1.2m) compared to the older girls (1.4m). It was found that the older girls were significantly heavier ($t = -7.7771$, $df=87$, $a<.0001$) and significantly taller ($t = -10.763$, $df=87$; $a.000$) than the younger boys. This suggests that the biomechanical benefits of being heavier and taller (older girls) compensated for the more efficient movement (younger but smaller and lighter boys) in producing a larger distance measures in the strike.
Coordination x Product x Process

Quadratic Surface
ZWAND vs. DMEAN vs. PMEAN
(Casewise deletion of missing data)
Path Analysis

* Denotes Significant Correlation
Summary of Results

• Rasch validated the amalgamated striking instrument (MASI) (AARE 2004)
• Case Estimates (process) compared to Product (distance) scores (PESP 2007)
• MANCOVA could then explore ZMAND with Process, Product and variability of performance (process only).
• Significant Effect for Age ($F=13.03$, $df=1,156$, $p=.0004$)
• Significant Effect for Sex ($F=37.64$, $df=1,156$, $p<.0001$)
• Variability of process performance relationship with Motor ability (ZMAND), age and gender
Implications of Findings

• For Researchers in the areas of:
  • DST
  • Motor Development
  • Skill Acquisition
  • PETE/Pre-service teacher education (generalists)
• Contribution to Literature

• Research often raises more questions than provide answers!!!
Implications For Researchers

• Whole body functioning (ZMAND)
• Process performance - place on a learning/developmental continuum
• Product and Process – and motor ability related. Previously not understood to this level + new thinking around this ‘relationship’
• Maturation? Multiple systems? Interactions of functioning levels…

• DST provides a framework within which to understand motor development and skill acquisition.
Implications for PETE

• New methodological applications (RASCH)
• New measures of related skilled performances (Process and Product)
• New knowledge – Process, Product and Coordination levels
• Confirmation of effect for Age and Gender
• Variability (or stability) of skill performance and ZMAND

• Expectations of Teachers
• Implications for Primary School Teachers of Physical Education

Stodden, Goodway, Langendorfer, Roberton, Rudisill, Garcia & Garcia., 2008
‘Sharing of the Research’

• Journal Articles
• International Conferences with associated publications online
• Targetted audience
• Pre-service teachers and educators
• Adding to Literature
• Adding to Theory

• ... some examples include:
Rasch Application to an Amalgamated Striking Instrument: Strike Two!

Paper for Full Refereeing
Measurement and Assessment SIG

Australian Association for Research in Education (AARE)
National Conference

November 2004. Melbourne Victoria

by

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ABSTRACT
Assessment of fundamental motor skill performance for primary school-aged children in Australia has been prevalent in the past decade. Measurement of a range of fundamental motor skills employed the component approach, a ceiling type of instrument. A high failure rate of
FUNDAMENTAL MOTOR SKILL AND COORDINATION - ESSENTIAL ELEMENTS FOR PERFORMANCE OUTCOMES OF PRIMARY SCHOOL-AGED CHILDREN.

Fully Refereed Paper for Presentation

FINAL

INTERNATIONAL COUNCIL HEALTH, PHYSICAL EDUCATION RECREATION SPORT DANCE

1ST ICHPER-SD OCEANIA CONGRESS 2006

OCTOBER 2006 WELLINGTON NEW ZEALAND

by

JUDITH MILLER. Ph.D.
PRIMARY SCHOOL-AGED CHILDREN AND FUNDAMENTAL MOTOR SKILLS – WHAT IS ALL THE FUSS ABOUT?

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Refereed Paper for publication and presentation at the Australian Association for Research in Education (AARE)

ABSTRACT
Fundamental motor skills are assumed to hold a key position on the movement education continuum for primary school-aged children. For example, mastery of fundamental motor skills is considered to be a precursor to their application in sport specific contexts, and conversely a lack of proficiency is lauded as a key reason for attrition from organised sport. The exploration of children’s coordination levels and their performance on a fundamental motor skill has revealed a significant relationship between these two movement constructs. Primary school-aged children (n=161) were
The relationship of process and product performance of the two-handed sidearm strike

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\textit{Background}: Many researchers are concerned with the proficiency of children in movement education. They are expressing this concern through the assessment of fundamental motor skills, owing to the established links between the proficiency of fundamental motor skills and subsequent involvement in sport and physical activity. The assessment of fundamental motor skills has predominantly employed a qualitative approach. Another form of assessment involves quantitative measurement; however, the relationship between process and product assessment paradigms is largely unexplored.

\textit{Purpose}: To investigate the relationship between the movement process and product measures of fundamental motor skill performances for primary school-aged children. The relationship between process and product assessment of fundamental motor skills is at the centre of this research.

\textit{Participants}: included 161 six to ten year-old children including 86 girls and 75 boys. The primary school-aged children participated in the study after parental permission and university ethics approval for the research were granted.

\textit{Research design}: involved a cross-sectional design which involved collecting data in an ‘ecologically
More in progress…

• Process – Product – ZMAND –
• DST motor development/skill acquisition/motor ability

Targetting Journals such as:
• Research Quarterly for Exercise and Science (USA)
• Physical Education and Sport Pedagogy (UK)
• Asia Pacific Journal of Sport, Health and Physical Education (Australia)
• Asia Pacific Journal of Pre-service Teacher Education (Australia)
Thank you and Questions?
Hypotheses Age/Sex/process and product

- **H1:** The mean distance score for the older age group will be significantly ($p < .05$) greater than the mean distance score for the younger age group.

- **H2:** The mean distance score for boys will be significantly ($p < .05$) greater than the mean distance score for girls.

- **H3:** The mean process score for the older age group will be significantly ($p < .05$) greater than the mean process score for the younger age group.

- **H4:** The mean process score for boys will be significantly ($p < .05$) greater than the mean process score for girls.

A focus on the relationship between distance and process is addressed in Hypothesis 9.

- **H9:** There will be a significant correlation ($p < .001$) for distance and process measure of performance.
Hypotheses

• H5: There will be no significant difference ($p < .05$) between mean distance scores across the six trials for boys and girls and for older and younger age groups.

• H6: There will be no significant difference ($p < .05$) between mean process scores across the six trials for boys and girls and for older and younger age groups.

• H7: There will be a significant correlation ($p < .001$) for distance scores between adjacent trials for all boys, girls and for older and younger age groups.

• H8: There will be a significant correlation ($p < .001$) for process scores between adjacent trials for all boys, girls and for older and younger age groups.
Variability of performance is explored in terms of age, sex, and coordination level for the amount of change at the component level, and is addressed by Hypotheses 10-12.

H10: Older subjects will display a significantly ($p < .05$) higher level of stability in process performance of the strike than younger subjects.

H11: Male subjects will display a significantly ($p < .05$) higher level of stability in process performance of the strike than female subjects.

H12: Coordination levels (ZMAND) will significantly correlate ($p < .05$) with levels of stability in process performance of the strike.

Hypothesis 13 seeks to find the process components of the strike that evidence more change than others over trials.

H13: Process components of the strike will be significantly different ($p < .05$) in terms of stability over trials.