Discovery Learning of Movements as a Teaching Strategy

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Introduction

- Purposes of this presentation
  - Present a specific approach to teaching and practicing motor skills
  - Begin a discussion about this approach's application to physical education and sports pedagogy

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Two Important Terms To Distinguish

Actions (*also called "skills"*)
➢ Goal-directed activities that involve body, head and/or limb movements
➢ Evaluated by whether or not action goal achieved
➢ Examples: Hitting a pitched baseball; performing a cartwheel; skipping across the room

Movements
➢ What body, head, or limb segments do when an action is performed
➢ Evaluated by movement analysis
➢ Examples: Movements used to perform the actions in the above examples

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3 Views of Skill Learning Suggest Teaching Differences for Actions and Movements

1. Gentile's Stages of Learning Model
   Learner's Goal for Each Stage
   - *Initial stage*: Learner's goal to acquire movement coordination pattern well enough to allow some degree of success at achieving the action goal of the skill
     - ◆ For the learner – An action oriented goal
   - *Later stages*: Learner's goal to develop consistency in action goal achievement, efficient use of energy, and adaptability
     - ◆ For the learner – A movement oriented goal

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3 Views of Skill Learning (*cont'd.*)
2. Bernstein's View of Optimal Practice Conditions

Bernstein, N. (1967, *The co-ordination and regulation of movements*, p. 134):

"'The processes of practice ... consists in the gradual success of a search for optimal motor solutions to the appropriate problems.

Because of this, practice, when properly undertaken, does not consist in repeating the *means of solution* of a motor problem time after time, but in the *process of solving this problem* again and again by techniques which we changed and perfected from repetition to repetition."

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3 Views of Skill Learning (*cont'd.*)
3. Adolph's View of How Infants Learn to Locomote

Infants acquire locomotion skills by "detecting novel and variable constraints on locomotion, and...discovering new solutions to respond adaptively."
- Adolph, K.E. (2008, *Current Directions in Psychological Science*), p. 214

Movement Problem Solving Hypothesis

Motor skill learning is enhanced to the degree that practice conditions engage learners in *movement problem solving*

The problem to be solved =	The problem solution (*solving the problem*) =
The action goal *e.g., throw a ball to a person standing 6 ft away*	The characteristics of movements that allow action goal achievement

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A Teaching / Practice Strategy That Promotes Movement Problem Solving: Discovery Learning of Movements

What is "discovery learning of movements"?
- The learner determines /discovers the specific movement characteristics needed for action goal achievement rather than having those characteristics prescribed

It occurs when the learner:
➢ Knows the action goal
➢ Has a minimum amount of movement information
➢ Must "discover" for himself/herself the optimal ways to move to achieve the action goal

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3 Practice Conditions that Engage People in Discovery Learning

1. Practice focused on achieving the action goal rather than on performing "correct" movements
   A. Instructions focused on action goal
   B. Learner's attention focus directed toward effects of movements rather than on movements themselves
2. Movement exploration of environmental variations
3. Feedback that encourages movement problem solving rather than provides movement solutions

1. Practice Focused on the Action Goal Rather than on Movements

A. Instructions based on action goal

2 research examples:

1. Klumpp & Magill (2004, *ACSM presentation*)
Task: Correctly insert an In-The-Ear (ITE) type of hearing aid shell
Subjects: 10 female college-age students
 - No previous hearing aid experience
Instruction conditions
1. Explicit movement instructions with demonstration
2. Instructions about action goal (*discovery learning of movements*)

Klumpp & Magill Experiment *(cont'd.)*

Practice session:
Attempt insertion until 3 consecutive correct – preferred hand side

Tests:
1. Retention
2. Bilateral Transfer
 * 4 days after practice
 * No instructions

Results

Practice Session	Retention Test
Explicit movement instruction group performed better	No statistical difference between groups

Bilateral Transfer Test
Action Goal Instruction Group - Significantly more correct insertions

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Practice Focused on Action Goal Rather Than on Movements *(cont'd.)*

2. Parr & Button (2010, *Int'l J. Sport Psychology*)

Subjects: Novice rowers

Task: Improve performance of the "catch" – the instant an oar blade enters the water

Instruction and Practice Conditions:
Action Goal Focus – Focus attention on the oar blade entering the water
Movement Focus – Focus attention on the movements that result in a "catch" being performed correctly

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Parr & Button Experiment *(cont'd.)*

Practice Sessions: 24 practice sessions over 6-wk period

Retention & Transfer Tests: 7 wks after practice

Results:

Practice: Action goal focus group showed more effective and efficient oar placement	Retention & Transfer: Action goal focus group maintained higher level of performance

Conclusion: Advantage for "action-goal" oriented practice for learning the rowing task

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B. Learner's Attention Focus on Movement Effects Rather than on Movements

Some Definitions:
Movement effects = The results (i.e. effects) of a movement (e.g., stepping on a stair step)
Attention Focus = Where conscious attention directed
 External focus = On movement effects or on environment
 Internal focus = On movements

⟹ Large amount of research shows: External Focus results in better learning and performance than an Internal Focus

e.g., Wulf & Su (2007, *RQES*)

Wulf & Su (2007) - Experiment 1

Participants: - 30 undergrads
 - Little to no experience playing golf

Task: Hit golf balls with a 9 iron into a circular target (50 cm radius) 15 m from target center

Target = 4 concentric circles: Scoring = 4,3,2,1 points

Attention Focus Groups:
External Focus – "Focus on the pendulum-like motion of the club"
Internal Focus – "Focus on the swinging motion of your arms"
Control – No attention focus instructions

All groups received instructions about grip, stance, & posture

Practice = 60 trials (with reminders of focus before each set of 10)
Retention = 1 day later (10 trials)

Wulf & Su (2007) - Experiment 1 *(cont'd.)*

Results

Practice trials	Retention trials
⟩All groups improved accuracy ⟩External focus group improved more than Internal and Control groups, which didn't differ	⟩ External focus group performed more accurately than Internal and Control groups, which didn't differ

Conclusion
Focusing attention on movement effects encourages action goal achievement by engaging in movement problem solving through non-conscious processes

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A Dance Teacher's Use of Attention Focus on Movement Effects

Suzanne Farrell teaches ballet to experienced students and professional dancers by instructing them to concentrate on the "effect" they want to create with their movements rather than on the movements they use to create the effect they want.

- Acocella, J. (January 6, 2003) *The New Yorker*, pp. 48-61

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3. Movement Exploration of Environmental Variations

Research example: Adolph's research with infants learning locomotion skills

Research goal: Determine what infants do to learn how to navigate variable and novel challenges in their environment

Infants (8 - 18 mo.) observed from first weeks of crawling to well after they begin walking:
 ⟩ Descending walkways of varying slopes
 ⟩ Walking over bridges of varying widths w/ and w/o handrails
 ⟩ Spanning gaps of varying distances

Adolph's Research *(cont.)*

Results of Adolph's research show

• Infants learn to adapt to environmental demands by exploring various ways of moving to achieve action goal

• This learning achieved with very large amounts of practice

e.g., One study showed that in 1 hr, 14-mo. olds:
➢ Took more than 2,000 walking steps
➢ Traveled a total distance of 7 football fields
➢ Fell 15 times

Results of Adolph's Research *(cont.)*

• The infants' behavior during their learning experiences were consistent with Gentile's 2 learning stages

"...in their first weeks of crawling and walking, infants plunged straight down impossibly steep slopes. Over weeks of locomotor experience, exploratory behaviors became more discerning and responses became more adaptive..." (Adolph, 2008, p. 214)

Conclusion: Infants learn adaptive locomotor skills by focusing on action goal achievement and by exploring movement solutions in a variety of environmental conditions

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4. Feedback That Encourages Movement Problem Solving Rather Than Movement Solutions

Winstein et al. (1996, *Physical Therapy*)

Types of feedback compared:
Concurrent – Available during performance
Knowledge of Results (KR) – Available after performance

Feedback conditions:
1. Concurrent feedback
2. KR after every trial
3. KR after every 5 trials

Task: Partial Weight-Bearing Goal = Support 30% body wt. while stepping on bathroom-type scale with preferred leg while on crutches

Participants: 60 20-40 y olds; no neuromuscular impairments

Practice: 80 trials
Retention Tests (no feedback): 20 trials 2 days post practice

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Winstein et al. Experiment *(cont'd)*

Results

	End of Practice	Retention Test
Concurrent	~ 1% Error	~ 12% Error
KR-1	~ 8% Error	~ 9% Error
KR-5	~ 8% Error	~ 9% Error

Conclusions
• Practice with post-performance feedback more effective for learning task than with feedback presented concurrently during performance

• Results consistent with movement problem solving hypothesis

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Summary

• Research evidence supports a "movement problem solving" hypothesis as a viable basis for developing teaching strategies and practice conditions

• "Discovery learning" is an effective means of engaging people in movement problem solving when learning motor skills

• "Discovery learning" teaching strategies and practice conditions can be implemented in various ways:

Summary (cont.)

3 ways to implement discovery learning teaching strategies and practice conditions:

1. Practice focused on achieving the action goal rather than on performing "correct" movements, *e.g.:*
   ➢ Instructions based on action goals
   ➢ Learner's attention focus on effects of movements rather than on movements themselves
2. Movement exploration of environmental variations
3. Feedback that encourages movement problem solving rather than provides movement solutions

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Application to Physical Education?

To what extent do you see Discovery Learning as a basis for developing teaching strategies and practice conditions in physical education classes?