

UTILIZING A KENDAMA FOR TRANSFER OF MOTOR LEARNING IN HIGH SCHOOL AND COLLEGE PHYSICAL EDUCATION

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Abstract

Classroom activities designed to teach novel upper limb skills can introduce students to the concept of transfer of motor learning through practice. Bilateral transfer of motor learning is the recognized effect of improvement in a physical skill from practicing the skill on the opposite side limb. The aim of this paper is to provide physical educators with guidelines for creating a motor learning activity to promote discussion of and a practice opportunity for students to transfer a movement skill from one hand to the other unpracticed hand. The framework for physical educators to implement a motor learning activity is presented with the example of using a hand-held wooden kendama. A kendama has a handle with cup surfaces and a wooden ball on a string such that the ball can be caught in a cup surface. The examples and suggested activity are for high school and college students to practice kendama catches only using the non-dominant limb. Students are given an opportunity through this activity to explore if practice on the non-dominant hand improved the skill on their other hand.



This practitioner paper aims to provide physical educators at the high school and college level with ideas, guidance, and a framework for implementing an engaging activity aimed to introduce motor learning concepts. The material presented will focus on teaching transfer of motor learning through introduction of a novel upper limb motor skill. Essentially, students can experience the motor concept that practicing a skill with one hand can improve the skill of the other unpracticed hand (Land et al., 2016). Practice of a new motor skill on the dominant limb has been demonstrated to transfer to the non-dominant limb and vice versa (Magill, 2011; Schmidt et al., 2019). Introducing and practicing a new physical skill on the non-dominant limb in a physical education lesson can be used as a progression in learning to explore motor performance. Training the non-dominant hand can be unexpected and enjoyable for those students looking for added challenge, and as a means to improve motor activities that incorporate the upper limbs (e.g., swinging, catching, throwing). Further, bilateral coordination can be beneficial in activities including but not limited to swimming, martial arts, floor hockey, gymnastics or paddling where accurate use of the left and right side of the body can be advantageous. Most students will choose to use their dominant hand when learning physical skills outside of the classroom and should be provided appropriate progressions once mastery of the dominant limb is demonstrated.

Research has demonstrated that shoulder, wrist and hand movements often exhibit bilateral transfer of learning (Aune et al., 2017; Land et al., 2016). Lower limb motor skills have a high variability when it comes to effectiveness of transfer of motor learning (Krishnan et al., 2017; Marcori et al., 2020). Therefore, it is recommended that educators choose a novel upper limb motor skill when teaching concepts of transfer of learning to students. The purpose of this manuscript is to provide a framework and example activity for high school and college students such that educators can introduce the experience of training their non-dominant hand and explore this motor learning concept. Specifically, students

will learn whether skill practice can benefit the skill of their other unpracticed hand.

Motor Learning Activity Design and Suggestions

Teaching bilateral transfer of motor learning is a physical activity that can be successfully implemented for high school or college students. The suggested motor learning activity meets Society of Health and Physical Educators (SHAPE) America standard 1 by allowing students opportunity to practice non-dominant hand movement patterns and transfer of learning between limbs (SHAPE, 2021). Specifically, exploring bilateral motor learning could lead to increased motor pattern competency in a variety of movement skills by expanding skills to the other side of the body. For example, bilateral skills could be beneficial in Frisbee catches or increased use of the non-dominant limb in ball sports such as water polo, soccer or basketball. Additionally, this motor learning activity aligns well with the California (CA) content standards for High School Course 1, specifically Standard 1.1 and 1.12, as students will use their understanding of training to improve the performance of the kendama skill. Also, through completion of this activity students will better understand motor learning concepts (i.e., practice planning, variable practice, transfer of motor skills) and therefore be more self-sufficient in learning skills and planning to improve skills.

When teaching motor learning concepts, it is important to choose a physical activity that is novel to most of the students. Upper limb skills work well for implementation of motor learning in physical education as upper limb skills generally require less space than novel lower limb skills and can be completed indoors if desired. Also, upper limb motor skills can easily be accomplished by students practicing simultaneously as a group in closer proximity than many lower limb skills. Proximity of students during training facilitates peer conversation and consequently student engagement.

This practitioner paper will present an example physical education activity utilizing a kendama with specific guidelines for

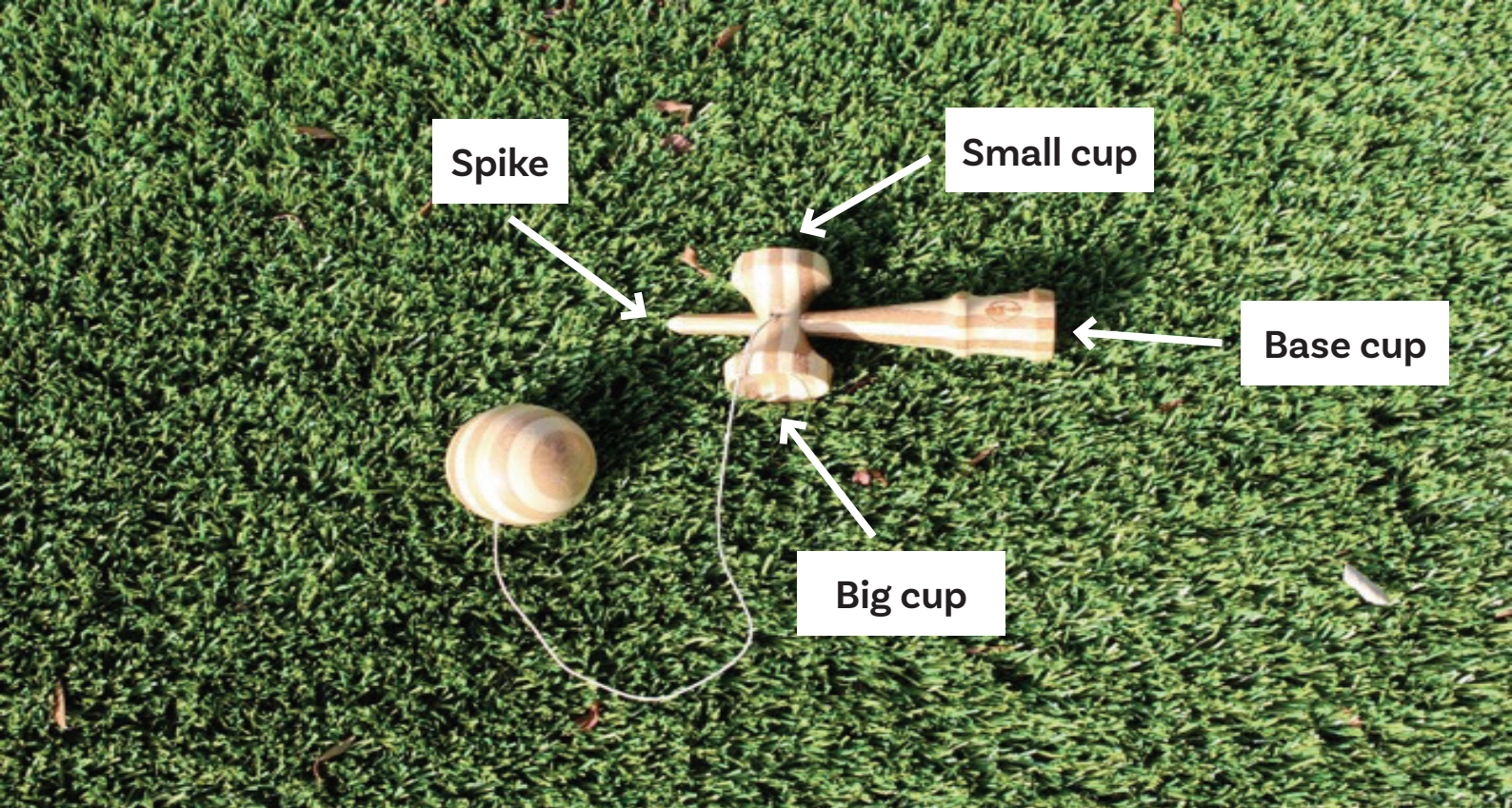


Figure 1. Hand-held kendama (Toysmith, Sumner, WA) with 4 catching surfaces for the wooden ball labeled.

high school and college students. However, the kendama activity can be easily modified to a different age level of student. A kendama is a traditional hand-held Japanese wooden toy. An example of a kendama (Toysmith, Sumner, WA) is displayed in Figure 1. Use of a kendama can aid in development of hand-eye coordination. Practice with a kendama could also potentially carry over to improved one-hand catches of a ball or disc with the non-dominant hand and enhanced timing of catching a moving object. Some other possible physical activities that can be taught on the non-dominant limb include juggling 1 or 2 balls in one hand or tapping a set of colored squares in a particular pattern. However, the kendama works well to successfully demonstrate motor learning in physical education classes.

Bilateral Transfer of Learning Example

Introduce the concept of bilateral transfer of motor learning. Educators can tell students that skills learned on one hand can improve the skill on their opposite hand. Teachers could also prompt for student participation by inquiring if the students think that practicing on their non-dominant hand will improve how well they can do a skill on their opposite hand. Use the op-

portunity to hear the students' perspectives. Teachers may hear a student say they can write with their non-dominant hand or other examples of using their non-dominant hand. Some students may share experiences about using both hands such as when playing musical instruments. Students may also volunteer anecdotes relating to how they are much better with their dominant hand. Ask students if they have ever practiced on the non-dominant hand. The educator can then explain that practice on the non-dominant hand can also lead to improved performance on the dominant hand. Alternatively, the question can be posed to students whether they expect transfer of performance ability to the opposite hand and the results can be left for students to discover at the conclusion of the activity. Students may discover that they can use their non-dominant hand better than they thought if they practice. Students may also learn that practicing on one hand can improve the other hand and therefore there is a possible benefit to practicing skills on both hands rather than just one side of the body.

Introduce the novel upper limb motor skill and equipment. Students will get to experience practicing an unfamiliar skill on their non-dominant hand. The kendama has a wooden ball on a string and 4 different catching surfaces of vary-

ing difficulty. It is suggested to choose one catching surface on the kendama and have all participants train to catch the wooden ball on that surface. The big kendama cup is generally the easiest for kendama catches while the spike is the most difficult (Figure 1). Experience with student groups has shown that the kendama big cup, base cup or small cup all work well as the designated catching surface for this activity. However, catching the ball on the spike has a high degree of difficulty and is not recommended. The instructor can encourage student engagement by having students be an active part of choosing the catching surface among big cup, base cup, and small cup.

It can be helpful to provide several demonstrations of attempts to catch the wooden ball on the kendama from the educator or a single student volunteer. Starting and ending positions for a kendama catch are shown in Figure 2. The attempt does not have to be successful to introduce the skill as high school and college students will understand the goal is to eventually be successful in landing the kendama ball on the catching surface. The demonstration can include an attempt on either or both non-dominant and dominant hands. It is best to keep the attempts limited if a student volunteers to demonstrate, as the demonstration itself should not amount to a practice session. If helpful to encourage interest, material on kendama catches or the chosen novel motor skill can be presented to inspire students. For example, videos are available on kendama club websites showing sequences of kendama catches and trick catches (e.g., KendamaUSA.com).



Figure 2. Starting position (left image) and ending position (right image) for catching the kendama ball in the small cup.

Design and explain the practice conditions. The goal of this stage is to establish practice duration and the number of attempts of the skill to complete during each practice. Research has demonstrated that five separate training sessions of 12.5-minutes results in transfer of motor learning for several different motor skills (Aune et al., 2017). Based on classroom experience, it is suggested that a minimum of six practice sessions are part of the kendama activity to achieve an improvement in motor skill and successful transfer to the other hand for all students. Examples of some suggested practice schedules with number of sessions and number of minutes of practice are given in Table 1. The number of practice sessions that will be used for the activity

can be chosen by the educator. The key is to have several practice sessions with at least 10-minutes of time devoted for each session. If using an activity other than the kendama, the amount of practice time and sessions should increase in proportion to the difficulty of the skill. The practice sessions can be on consecutive days or as infrequent

as once a week. Plan to practice with the students each time they meet for class. It

is suggested for the kendama activity to have all students stand during practice (Figure 3).

High school and college students may enjoy contributing ideas and suggestions for designing the practice of the unfamiliar skill on the non-dominant hand. The teacher can determine the number of class periods or practice sessions that will be completed. Deciding on the exact practice duration can be accomplished by giving the participants options equal to or greater than the number of

Table 1: Suggested practice session schedules for non-dominant hand kendama catches for high school and college students. Practice minutes per session is the suggested minimum.

Practice sessions (#)	Practice per session (minutes)
6	18
8	15
10	12
12	10
15	10

minimum practice minutes suggested in Table 1. Also, students can discuss together and decide on the minimum times they should attempt the chosen kendama catch during practice. Figure 4 provides an example of high school or college-level kendama activity guidelines for transfer of motor learning.

Assess the motor skill for each student before any practice. The first baseline assessment can be completed informally by having students self-report or formally by having other students or the physical educator involved in the count and recording of successful kendama catches. Clipboards, paper and pens can be provided for students to record the kendama catches. Example assessment recording sheets for kendama catches are given in Table 2. The assessment should include recording the number of successful catches on both the dominant and non-dominant hand for each participant. When completing the first assessment, a student should complete all 20 attempts at catching the ball on one hand before moving to the other hand to complete 20 attempts for assessment. Catches should be counted for both hands such that bilateral transfer of learning can be demonstrated after completing all practice sessions and comparing the number of successful catches after practice. Recording the baseline catches count can also help students remember what their skill level was when they first started learning the motor skill. The dominant hand can be marked on the recording sheet such that the educator can have a record of the dominant hand when comparing the first assessment to the assessment after practice. The educator can instruct students to work in groups of 3 to record the successful number of kendama catches with one student attempting catches, one student counting total attempts up to 20 on each hand and one student recording the tally of catches on the recording sheet

(Table 2). Once a student has completed 20 attempts of kendama catches on each hand, have the students rotate responsibilities for recording the next student’s assessment.

Practice on the non-dominant hand for several sessions. Schedule and implement several sessions of practice or training on the non-dominant limb with the practice conditions agreed upon by the class. Once the catching surface has



Figure 3. A student stands to practice attempts at catching the wooden kendama ball on the small cup.

Figure 4. Kendama Activity Guidelines Example for High School and College students.

Practicing kendama catches on your non-dominant hand only can improve how well you can catch the kendama ball while improving the skill on your other hand as well. We will assess how well you can catch the kendama ball on both hands. Then, you will practice on your non-dominant hand only for several practice sessions. After completing all practice sessions, you will be assessed on both hands and reflect on whether practice on one hand improved that hand only or your other hand also.

Equipment: Kendamas, clipboard, paper, pen, timer

Quick write or quick share (5 minutes): Do you think you will improve catching the ball on the kendama on both hands or only the hand you practice on? Why?

- **Step 1. Introduce the kendama**
- **Step 2. Design practice conditions as a class- non-dominant hand practice only**
Choose catching surface for the entire class to practice:
___ Big cup ___ Small cup ___ Base cup
 - o Practice every day class meets
 - o Number of total practices (circle): 6 8 10 12
 - o Number of minutes per practice session (circle): 18 15 12 10
 - o Minimum number of attempts per practice session (circle): 20 30 40
- **Step 3. Count number of kendama catches before any practice**
You will work in groups of 3. One student attempts catches, one counts total number of attempts and one counts catches.
 - o On a separate sheet, record student name or initials and a place to record left or right hand catches
 - o Tally attempts: Mark I for a catch and X for a miss
 - o Each student completes 20 attempts for catches on the chosen cup on each hand.
 - o Count number of successful catches per handBegin your first practice session as soon as you are done with assessment.
- **Step 4. Complete all practice sessions on non-dominant hand only**
- **Step 5. Repeat the assessment procedure in Step 3 for final assessment**
- **Step 6. Compare the number of catches on both left and right hands between initial assessment and final assessment. Did the number of catches improve only on your non-dominant practiced hand, or did practice on one hand improve the skill of the other hand?**

been chosen, there is no need to limit practice to only one catching surface as long as students do practice the minimum number of attempts on the chosen kendama catching surface. Constrain practice to be completed on the non-dominant limb only.

An activity for teaching bilateral transfer of a motor skill can be a stand-alone lesson, or it can be implemented in conjunction with other physical education learning activities. For example, the kendama skill practice can be implemented over several sessions as a beginning-of-class or end-of-class task combined with other physical education content.

Participants can practice the novel motor skill together in a group learning environment. Practicing as a group allows time for students to socialize while discussing the skill. Students may enjoy sharing techniques they have tried or observations about their own skill learning process. Cooperative learning techniques such as Think-Pair-Share work well to implement during practice sessions (Freeman et al., 2014). Educators can pose a question to participants as they train, such as asking students to suggest skills that would benefit from better use of their non-dominant hand or asking if students have changed how they think about practicing skills with their non-dominant hand. Then have participants pair

Table 2. Examples of recorded assessment sheets for number of catches and misses of the kendama ball for college students before and after practice.

First baseline count of kendama catches on left and right hands for several college students before completing any practice.

20 attempts to catch the kendama ball per hand tallied in 2 rows of 10:

- 1 marks a catch
- X marks a miss
- Total successful catches written to the right of each 20 attempt tally
- * marks the dominant hand of the student

Name: K.D.		First count of catches, before any practice	
Right*	Left		
X X X X X X X X X X 3	X X X X X X X X X X 6		out of 20 * Marks dominant hand
Name: K.J.			
Right	Left*		
X X X X X X X X X X 2	X X X X X X X X X X 9		
Name: J.T.			
Right*	Left		
X X X X X X X X X X 1	X X X X X X X X X X 4		
Name: N.M.			
Right*	Left		
X X X X X X X X X X 2	X X X X X X X X X X 2		
Name: D.L.			
Right*	Left		
X X X X X X X X X X 11	X X X X X X X X X X 2		

Final count of kendama catches on left and right hands for several college students after completing all non-dominant hand practice sessions.

- 1 mark a catch
- X marks a miss
- Total successful catches written to the right of each 20 attempt-tally

Name: K.D.		Final count of catches, after all practice sessions	
Right	Left		
X X X X X X X X X X 13	X X X X X X X X X X 11		
Name: K.J.			
Right	Left		
X X X X X X X X X X 9	X X X X X X X X X X 11		
Name: J.T.			
Right	Left		
X X X X X X X X X X 4	X X X X X X X X X X 8		
Name: D.L.			
Right	Left		
X X X X X X X X X X 16	X X X X X X X X X X 12		
Name: J.T.			
Right	Left		
X X X X X X X X X X 16	X X X X X X X X X X 9		
Name: N.M.			
Right	Left		
X X X X X X X X X X 15	X X X X X X X X X X 13		

with others and share with the whole group to promote reflection on the physical activity.

Assess the motor skill of each participant after practice. After completing several practice sessions, participants can take a final assessment to show improvement and demonstrate bilateral transfer of motor learning. This assessment can also be formal or informal, mirroring the initial assessment done before any training sessions. In a similar manner to the initial assessment, have students complete the

same number of attempts as the previous assessment. The number of successful attempts can be counted and recorded for both dominant and non-dominant limb for each participant. Allow time for students to compare initial to final assessment. Compare improvement both on the dominant and non-dominant hand. Improvement in the number of catches on the dominant hand demonstrates that the motor skill was transferred from the non-dominant hand practice.

Concluding Remarks

Physical education activities that teach concepts of bilateral transfer of learning give students understanding that can be carried over into other physical activities they may choose to explore or participate in. For example, practice using a non-dominant hand or foot could potentially augment skill options for students in sports activities. The kendama exercise can also help with coordination for other upper limb motor skills including but not limited to rhythmic gymnastics, dance movements, juggling, or non-dominant hand playing of table tennis. A transfer of motor learning activity promotes understanding of how we learn new physical skills. Additionally, students can appreciate upon completion of the activity that there may be a benefit to practicing on both dominant and non-dominant sides of their body. Further, the suggested activity offers many opportunities for student engagement (Ennis, 2017). Educators can guide students through the challenging experience of practicing on the non-dominant limb while teaching them knowledge that can be applied to learning other physical activities throughout their life. The suggested activity allows for student contribution in designing the type of catch on the kendama. Practice sessions provide an opportunity for students to socialize and discuss potential practice techniques and skill progress with their peers. Teacher involvement in the practice sessions provides an opportunity to listen to student conversation and prompt for reflection and peer conversation on acquisition of novel motor skills and use of the non-dominant limb. Developing and implementing an activity on transfer of motor learning can broaden the physical education experiences of students in a challenging and engaging way.

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Acknowledgements

The author gratefully thanks Paul T. Stuhr for his insight and help with editing parts of this paper.