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Research article

Assessing Motor Skill Competency in Elementary School Students: A Three-Year Study

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Abstract
This study was to examine how well fourth- and fifth-grade students demonstrated motor skill competency assessed with selected PE Metrics assessment rubrics (2009). Fourth- and fifth-grade students (n = 1,346-1,926) were assessed on their performance of three manipulative skills using the PE Metrics Assessment Rubrics during the pre-intervention year, the post-intervention year 1, and the post-intervention year 3. Descriptive statistics, independent t-test, ANOVA, and follow-up comparisons were conducted for data analysis. The results indicated that the post-intervention year 2 cohort performed significantly more competent than the pre-intervention cohort and the post-intervention year 1 cohort on the three manipulative skill assessments. The post-intervention year 1 cohort significantly outperformed the pre-intervention cohort on the soccer dribbling, passing, and receiving and the striking skill assessments, but not on the throwing skill assessment. Although the boys in the three cohorts performed significantly better than the girls on all three skills, the girls showed substantial improvement on the overhand throwing and the soccer skills from baseline to the post-intervention year 1 and the post-intervention year 2. However, the girls, in particular, need to improve striking skill. The CTACH PE was conducive to improving fourth- and fifth-grade students' motor skill competency in the three manipulative skills. This study suggest that PE Metrics assessment rubrics are feasible tools for PE teachers to assess levels of students' demonstration of motor skill competency during a regular PE lesson.

Key words: Subject matter competency, quality teaching practices, manipulative skills.

Introduction

Participation in regular physical activity is essential for youth to improve physical, mental, and social health. Researchers reported a positive relationship between motor skill proficiency and physical activity participation and a negative relationship between motor skill proficiency and sedentary activity in children (Barnett et al., 2009; Fisher et al., 2005; Okely et al., 2001; Wrotniak et al., 2006). It was empirically found that children's total time spent in physical activity and time spent in moderate-to-vigorous physical activity were significantly associated with their total movement skills score. Furthermore, children in the top quartile of motor skill proficiency spent a significant more time in moderate to vigorous physical activity compared to children with lower levels of motor proficiency (Barnett et al., 2009; Fisher et al., 2005; Okely et al., 2001; Wrotniak et al., 2006). Children with greater motor skill proficiency were more likely to participate in physical activity than their counterparts with poor motor skill proficiency during their adolescent years (Barnett et al., 2009; Okely et al., 2001; Wrotniak et al., 2006).

Children's demonstration of competency in motor skills is considered as a cornerstone leading to their physical and motor development. Fundamental motor skills are building blocks to successful participation in many organized and non-organized sports and various physical activities for children, adolescents and adults (Barnett et al., 2009; Okely et al., 2001; Rovegno and Bandhauer, 2013). These fundamental motor skills, including locomotor skills, manipulative skills, and non-manipulative skills, are commonly used in many forms of sports and physical activities. Children's motor skills are not developed naturally as a result of physical growth. Development of motor skill competency is based on the dynamic interaction among the task, the learner, and the environment. Motor skill development must be learned and practiced within a sequentially structured learning environment based on children's sequence of motor development (Clark, 2005; Gallahue and Ozmun, 2006; National Association for Sports and Physical Education [NASPE], 2004; Rovegno and Bandhauer, 2013). Quality physical education offers a wide array of physical activities and fitness that are developmentally appropriate and enjoyable for students; uses meaningful and appropriate instructional practices to provide students with maximum learning experiences; and ensures students to spend 50% of class time in MVPA (NASPE, 2004; Rovegno and Bandhauer, 2013).

As an evidence-based quality physical education program, the Child and Adolescent Trial for Cardiovascular Health (CATCH) was initiated in 1991 and designed as a comprehensive elementary school physical education and nutrition program which was funded by National Heart, Long, and Blood Institute of National Institute of Health (NIH) (McKenzie et al., 1996). The CTACH Physical Education (PE) component focused on developing students' motor skill competency, health-related fitness, and enjoyment of physical activities through providing developmentally appropriate physical education content and increasing moderate-to-vigorous physical activity (MVPA) in physical education classes. The CATCH intervention was implemented in 96 elementary schools in four U.S. cities. The results showed that the intervention schools increased students' MVPA from 37% to 52% of class time, higher than the 50% MVPA in PE class guideline for quality physical education (McKenzie et al.,

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1996). After 5-7 years later of the CATCH PE intervention, the study reported that students' average time spent in MVPA during PE classes was either maintained (4^{th}-5^{th} grades) or increased (3^{rd} grade) (McKenzie et al., 2003). Over the past two decades, CATCH PE has evolved as a comprehensive standards-based curriculum (Centers for Disease Control and Prevention-CDC, 2008). For example, the CATCH PE provides developmentally appropriate and meaningful physical education content for elementary school students. The scope and sequence of CATCH PE maps most of the essential content addressed by the 3-5 grade expectations of the NASPE content standards (NASPE, 2004). However, no studies have been conducted to examine how the CATCH PE contributed to students' development of motor skill competency. Therefore, little is known about how the current CATCH PE contributes to children's motor skill competency in the intervention conditions.

The NASPE content standard 1 (NASPE, 2004) describes students in grades K-12 should demonstrate competency in motor skills and movement patterns needed to perform a variety of physical activities, as a result of participating in quality physical education program. According to Grade Expectations for grades 3-5, students need to demonstrate the mature form of fundamental movements and basic specialized skills, to be able to combine one skill with another, and to apply the skills in dynamic situations. Since the first edition of the NASPE seven content standards was published in 1995 and was revised into five content standards in 2014, there were no valid and reliable standards-based assessments measuring students' achievement of the national physical education content standards in the United States.

To address the pragmatic need, NASPE formed an Assessment Task Force (ATF) in January 2000 (NASPE, 2008). The ATF consisted of researchers in physical education pedagogy and measurement/evaluation, teacher educators, K-12 physical education teachers, and administrators. With the intent to select most critical and representative of movement activities taught at the Kindergarten, Grade 2, and Grade 5 levels, they designed 30 assessment items corresponding to the NASPE content standard 1. After four years of extensive testing with 4,000 students at 90 schools across the nation (NASPE, 2008), the NASPE (2008) published PE Metrics: Assessing the National Standard 1: Elementary. PE Metrics (NASPE, 2008) is the only series of performance-based assessment rubrics specifically designed to assess levels of students' competency in motor skills and movement patterns with the criteria directly mapping the Grade-Range Expectations of the NASPE (2004) Content Standard 1 and Performance Outcomes. PE Metrics (NASPE, 2008) provide valid and reliable ready-to-use assessments for assessing grades 4-5 students basic specialized skills in selected game forms, use of offense and defense game strategies, dance and gymnastics sequences (NASPE, 2008; Dyson et al., 2011; Fox et al., 2011; Zhu et al., 2011a; 2011b).

Since the PE Metrics (NASPE, 2008) was published, no study has been conducted to examine the progress of fourth- and fifth-grade students demonstrated motor skill competency in relation to NASPE content standard 1 using the PE Metrics assessments (2008) in school settings. There has been an increasing recognition of the importance in developing motor skill competency among elementary school students and a call for a quality physical education. Therefore, the purpose of this study was to examine how well fourth- and fifth-grade students demonstrated motor skill competency that were assessed using selected PE Metrics assessment rubrics (NASPE, 2008) as a result of participating in a quality physical education program: the CATCH PE during physical education. This is the first study to describe the extent to which students in grades 4-5 demonstrated competency in motor skills that were assessed by using the standards-aligned PE metrics assessment rubrics. The significance of this study lies in providing empirical evidence for how a quality physical education can impact students' achieving desired learning outcomes in relation to the NASPE content standard 1.

Methods

Participants and research settings

Participants in this study were nine elementary physical education teachers and the fourth- and fifth-grade students at nine elementary schools in the same school district located in the suburban area of the Mid-West of the United States. Five physical education teachers were females and four were males. They all were Caucasian. Their ages ranged from 33 to 55 years old and their teaching experience varied from 6 years to 26 years. Students, ranging from 1,387 to 1,398, participated in the pre-intervention; Students between 1,346 and 1,926 participated in the post-intervention year 1; and students between 1,361 and 1,496 participated in the post-intervention year 2; Student population was dominantly White (91.2% Caucasian; 48% female and 52% male). The fourth and fifth grade students had a 60-minute physical education class per week. The class size ranged from 18-28 students.

The university institutional review board and the school district granted the permission for conducting this study. All nine physical education teachers signed the consent form to indicate their willingness to participate in this study. The parent/guardian of the fourth and fifth grade also signed the consent form to grant the permission of their child for participating in this study. The assent form was also distributed to the students to have them decide whether or not they wanted to participation in this study, even though their parent/guardian approved their participation in this study.

Background of this study

The reason for selecting the nine elementary physical education teachers and their fourth- and fifth-grade students as the participants for this study was that their school district housing nine elementary schools received a three-year Carol White Physical Education Program (PEP) grant which is funded by U.S Department of Education in 2009. Since the PEP program began in 2001, the U.S. Department of Education has awarded more than $ 620 million to local educational agencies and community-

based organizations to help them initiate, expand, and/or enhance physical education programs for students in kindergarten through 12th grade to meet their state standards for physical education (U.S. Department of Education, 2013). The nine physical education teachers and their students indicated their willingness to participate in the PEP grant project titled, "Smart Kids and Healthy Kids" which was designed to help elementary school students become physically active, mentally healthy, and social cooperative children through improving a quality of physical education program. As a part of the three-year PEP grant project, this study focused on examining and reporting the primary outcome of achieving the PEP project objective #1: Students in grades 4-5 will demonstrate competency in movement forms as a result of the physical education teachers learned and implemented CATCH PE curriculum lessons and objectives in their classes.

Given the goals and objectives of the PEP grant program, randomly controlled trial (experimental design consisting of control and intervention groups) was not suitable for this study. To help all fourth- and fifth-grade students achieve the content standard 1 (the objective #1 of the PEP project), all nine elementary schools were in the intervention condition in which the CATCH PE curriculum was implemented by the nine physical education teachers during their regular physical education classes. All fourth- and fifth-grade students who enrolled in the nine elementary school students were recruited to participate in this study. To examine the effect of the intervention on the students' achievement of motor skill competency, pre- and post- tests research design was used for this study.

During the PEP year 1 (the pre-intervention phase), all nine physical education teachers participated in a two-day CATCH PE curriculum workshop and staff development. During a full-day the CATCH School Implementation Training Workshop presented by a CATCH training specialist, All nine physical education teachers learned the best practices of the CATCH PE lessons, participated in hands-on CATCH PE training activities, and discussed strategic plans for implementing CATCH PE in their current PE programs. During another full-day staff development and workshop, all nine physical education teachers studied the CATCH PE grade-specific curriculum guidebooks and identified the plan for incorporating a few CATCH PE units into their current PE programs. Meanwhile, to help the teachers effectively conduct the PE Metrics assessments with their students, a full-day workshop on PE Metrics assessments was held. All nine physical education teachers learned grade-specific and skill-specific assessment rubrics, assessment criteria, assessment tasks, and testing protocols.

Prior to the intervention, baseline motor skill assessments were conducted with the fourth- and fifth-grade student by their trained physical education teachers using the PE Metrics Assessments, including soccer dribbling, passing, and catching skills, overhand throwing skills, and striking skill.

To facilitate the teachers to implement CATCH PE lessons, each teacher was provided with a CATCH PE curriculum package including over 500 activities focusing on skill themes and physical fitness activities, and adequate equipment by specified PEP grant money allocated to the curriculum implementation. During the post-intervention year 1(PEP project year 2), each physical education teacher had taught 72 PE lessons to students in grades 4-5 during the school year. Each teacher was required to teach CATCH PE lessons to their students per week, while using the Curriculum Log to record what specific CATCH PE content they taught per week throughout the school year. Analysis of the Curriculum Log indicated that the nine teachers, on average, taught 37 CATCH PE lessons to their students. In other words, 51% of the PE lessons taught with CATCH PE curriculum lessons, including a variety of locomotor skills and manipulative skills within the context of modified games, basic specialized skills used in team and individual sports, and physical fitness activities. At the end of each CATCH PE unit, the physical education teachers conducted the motor skill assessment with their fourth- and fifth-grade students.

During the post-intervention year 2 (PEP project year 3), analysis of the Curriculum Log indicated that the nine teachers, on average, taught 55 CATCH PE lessons to their students. In other words, 77% of the PE lessons taught with CATCH PE curriculum lessons. Similar to the PEP project year 2, the content of CATCH PE lessons consisted of fundamental manipulative skills such as dribbling, kicking, punting, catching, underhand throwing, overarm throwing, volleying, striking with rackets, striking with long handled implements, and basic specialized skills used in team and individual sports as well as a variety of locomotor skills and physical fitness activities. At the end of each CATCH PE unit, the physical education teachers conducted the motor skill assessments with their fourth- and fifth-grade students.

To examine how well the nine PE teachers' teaching practices were associated with quality teaching, the investigators video-recorded the nine PE teachers' teaching 45 CATCH PE lessons to their students throughout the PEP project year 2 and year 3 and assessed the 45 video-recorded lessons using the Assessing Quality of Teaching Rubrics (Chen et al., 2012). The results of quality teaching assessment indicated that among the 45 video-recorded lessons, the nine teachers on average fully demonstrated the quality of Task Design and Class Management, mostly implemented the quality of Task Presentation, and partially provided the quality of Instructional Responses to students' learning. Also, another promising results showed that the nine teachers mostly demonstrated overall quality teaching when teaching 45 CATCH PE lessons throughout the two PEP project year (Chen, Hypnar, Mason, & Zalmout, 2014).

Motor skill assessments

Each trained physical education teacher used the PE Metrics assessments rubrics to formally assess their own students' skill performance during their regular physical education lessons. Each teacher was required to strictly use the PE Metrics Assessment testing protocols, directions, assessment criteria, assessment rubrics, and assessment tasks to conduct the assessment with one student at a

Table 1. A score range for each essential dimension and the total score of the three PE metrics assessments.

Skill Assessment	Essential Dimensions			Total Score
Soccer skills (one trial)	Dribbling (0-4)	Passing (0-4)	Receiving (0-4)	(0-12) 9=Competent
Baseball overhand throwing (three trials)	Form (0-4) 1^{st} 2^{nd} 3^{rd}	Accuracy to Target (0-4) 1^{st} 2^{nd} 3^{rd}		(0-24) 18=Competent
Tennis striking skill (one trial)	Form (0-4)	Continuous Strikes (0-4)		(0-8) 6=Competent

time. The PE Metrics Assessment rubric is designed as skill-specific assessment tool. Based on the unique nature of a skill, each assessment rubric has its own unique essential dimensions and performance indicators on each rating scale as well as the number of trial for testing. Table 1 presents each of the three PE Metrics Assessments in terms of essential dimensions, the 0-4 rating scale with level 3 represents a competent level, a total score, and the number of trial for the test (NASPE, 2008).

For the soccer dribbling, passing, and receiving skills assessment, the students' performance levels were assessed on the three essential dimensions: Dribbling, Passing, and Receiving with a 0-4 rating scale. One trial was allowed for the test. Criteria for Competence (level 3) for Dribbling is: "dribble with control while moving at a slow, consistent jog," for Passing is: "sends a receiving lead pass to a partner so it can be caught outside the passing lane without a break in the receiver's stride on at least 3 passes," and for Receiving is: "moves forward and outside the passing lane to meet the ball and receiving at least 3 receivable passes" (NASPE, 2008). A total score of 9 indicated an overall competent level.

In the overhand throwing skill assessment, students were assessed on their performance levels of Form and Accuracy to Target using a 0-4 rating scale. Criteria for Competence (Level 3) for Form are: "throws with selected essential elements: a) throwing elbow shoulder-high, hand back and side orientation in preparation for the throw. b) trunk rotation, with elbow lagging behind hip. c) weight transfer to non-throwing forward foot." For Accuracy to Target is: "hits target area on wall" (NASPE, 2008, p. 117). Each student was given 3 trials. A total score of 18 indicated an overall competent level.

For the striking skill assessment, the students' performance levels were assessed on the two essential dimensions: Form and Continuous Strikes using a 0-4 rating scale. Criteria for Competence (Level 3) for Form are: "usually uses a side orientation" and for Continuous Strikes are: "strikes the ball continuously against the wall 5 times from 10 feet with added strokes that may be in front of the 10-foot striking line" (NASPE, 2008, p. 126). One trial was allowed for the test. A total score of 6 indicated overall competent level. PE Metrics (NASPE, 2008) provide more detailed information about each assessment rubric criteria, performance indicator, and each assessment protocols.

Data analysis

Descriptive statistics and percentages were computed to determine levels and proportions of the students' demonstration of competency in each of the three skills. ANOVA was utilized to examine the mean score difference in each skill assessment between the pre-intervention cohort, the post-intervention year 1 cohort, and the post-intervention year 2 cohort, followed by a post-hoc Dunnett T3 method. An independent t-test was conducted to examine the mean score difference in each skill assessment between the boys and the girls. An alpha level of .05 was used for all tests.

Results

Mean score differences of motor skill competency between three cohorts

Table 2 presents the descriptive statistics of overall motor skill score on each assessment during the pre-intervention (baseline data), post-intervention year 1, and post-intervention year 2. For the soccer dribbling, passing, and receiving skill assessment, a total score of 9 indicated the overall competent level. During the pre-intervention (baseline), 1,395 students who completed the test on average demonstrated slightly higher than the competent level (M = 9.12, SD = 2.37). 993 (71%) students reached the competent level or above. In the post-intervention year 1, 1,346 students who completed the assessment on average demonstrated higher than the competent level (M = 9.35, SD = 1.97). 999 (74%) students demonstrated the competent level or above. In post-intervention year 2, 1,377 who

Table 2. Skill assessment performance of the students in the three cohorts.

Soccer Dribble, Pass, Receive	N	M	SD	SE	$C_{competent}$	$\%_{competent}$
Baseline	1395	9.12	2.37	.06	993	71
Post-Intervention Year 1	1346	9.35	1.97	.05	999	74
Post-Intervention Year 2	1377	9.61	1.82	.05	1032	75
Overhand Throwing	**N**	**M**	**SD**	**SE**	$C_{competent}$	$\%_{competent}$
Baseline	1398	18.65	4.48	.12	993	67
Post-Intervention Year 1	1926	18.86	3.48	.08	1244	65
Post-Intervention Year 2	1496	20.27	3.30	.09	1201	80
Forehand Striking	**N**	**M**	**SD**	**SE**	$C_{competent}$	$\%_{competent}$
Baseline	1387	5.56	1.96	.53	722	52
Post-Intervention Year 1	1348	5.81	1.63	.05	753	56
Post-Intervention Year 2	1361	6.10	1.50	.04	870	64

performed the skill assessment on average demonstrated moderately higher than the competent level (M = 9.61, SD = 1.82). 1,032 (75%) students demonstrated the competent level or above. The results of ANOVA indicated a significant difference of the mean scores between the three groups (F = 19.66, df = 2, p < .01). The post-hoc Dunnett T3 tests revealed that both the post-intervention year 1 cohort and the post-intervention year 2 cohort scored significantly higher than the pre-intervention cohort (mean-difference = .23, p < .05; mean-difference = .49, p < .01). Further, the post-intervention year 2 cohort scored significantly higher than the post-intervention year 1 cohort (mean-difference = .27, p < .01).

Regarding the overhand throwing skill assessment, a total score of 18 indicates an overall competent level. In the pre-intervention (baseline), 1,397 students who took the test on average demonstrated slightly higher than the competent level (M = 18.65, SD = 4.48). 933 (67%) students demonstrated the competent level or above. In post-intervention year 1, 1,926 students who performed the assessment on average demonstrated higher than the competent level on average (M =18.86, SD = 3.48). 1,244 (65%) students reached the competent level or above. In the post-intervention year 2, 1,496 students who completed the assessment on average demonstrated much higher than the competent level on average (M = 20.27, SD = 3.30). 1,201 (80%) students in the post-intervention year 2 cohort demonstrated the competent level or above. The results of ANOVA yielded a significant difference of the mean scores between the three cohorts (F = 83.74, df =2, p < .01). The post-hoc Dunnett T3 tests indicated no significant difference of the mean scores between the pre-intervention cohort and the post-intervention year 1 cohort (mean-difference = -.21, p >.05). However, the post-intervention year 2 cohort scored significantly higher than both the pre-intervention group (mean-difference = 1.62, p < .01) and the post-intervention year 1 cohort (mean-difference = 1.41, p < .01).

For the forehand striking skill, a total score of 6 indicates an overall competent level. In the pre-intervention (baseline), 1,387 students who completed the test on average demonstrated lower than the competent level (M = 5.56, SD = 1.96). 722 (52%) students in the pre-intervention cohort demonstrated the competent level or above. In post-intervention year 1, 1,348 students who participated in the forehand striking assessment demonstrated slightly lower than a competent level on average (M = 5.81, SD = 1.63). 753 (56%) students in the post-intervention year 1 cohort demonstrated the competent level or above. In post-intervention year 2, 1,361 students who performed the assessment demonstrated a competent level (M = 6.10, SD = 1.50). 870 (64%) students in the post-intervention year 2 cohort demonstrated the competent level or above. The results of ANOVA revealed a significant difference of the mean scores between the three cohorts (F = 33.98, df =2, p < .01). The post-hoc Dunnett T3 tests indicated that both the post-intervention year 1 cohort and the post-intervention year 2 cohort scored significantly higher than the pre-intervention group (mean-difference = .24, p < .01; mean-difference = .54, p < .01). The post-intervention year 2 cohort scored significantly higher than the post-intervention year 1 cohort (mean-difference = .30, p < .01).

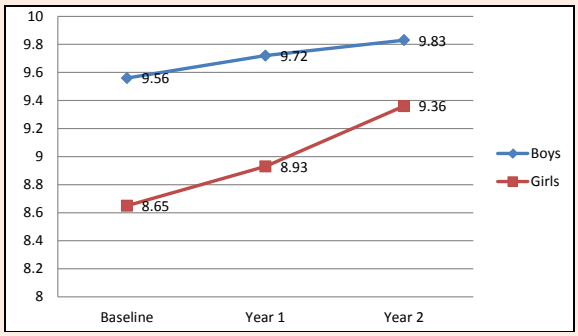

Figure 1. Mean scores of soccer skills assessments for boys and girls in the three cohorts.

Gender differences of motor skill competency in three cohorts

Gender differences in soccer skill competency: Figure 1 presents gender differences of motor skill competency in soccer skill assessment among three cohorts. 724 boys and 671 girls completed the baseline soccer skill assessment. The boys' mean score (M = 9.56, SD = 2.22) was slightly higher than the competent level. In contrast, the girls' mean score (M = 8.65, SD = 2.42) was lower than the competent level. The results of t-test revealed that the boys significantly outperformed the girls on the soccer dribbling, passing, and receiving (t = 7.33, df = 1358, p < .01). In the post-intervention year 1, 705 boys and 641 girls completed the skill assessment. The boys' mean score (M = 9.72, SD = 1.87) was higher than the competent level, while the girls' mean score (M = 8.93, SD = 2.01) was slightly lower than the competent level. The results of t-test revealed that the boys performed significantly better than the girls on the soccer dribbling, passing, and receiving (t = 7.50, df = 1344, p < .01). In the post-intervention year 2, 745 boys and 632 girls completed the assessment. The boys' mean score (M = 9.83, SD = 1.82) was higher than the competent level. The girls' mean score (M = 9.36, SD = 1.80) was also higher than the competent level. The results of the t-test indicated that the boys scored significantly higher than the girls on soccer dribbling, passing, and receiving (t = 4.74, df = 1375, p < .01).

Examination of boys' mean score differences on the soccer skill assessment between three cohorts by means of ANOVA revealed significant differences between the three groups (F = 3.38, df =2, p < .05). The post-hoc Dunnett T3 test indicated that the post-intervention year 2 cohort scored significantly higher than the pre-intervention group (mean-difference = .27, p < .05). However, the post-hoc Dunnett T3 tests revealed no significant difference between the post-intervention year 1 cohort and the pre-intervention cohort (mean-difference = .17, p > .05) and between the two post-intervention cohorts (mean-difference = .10, p > .05).

In contrast, examination of girls' mean score differences on the soccer skill assessment between three cohorts by means of ANOVA revealed significant differ-

ences between the three groups (F = 19.09, df =2, p < .01). The post-hoc Dunnett T3 test indicated that both the post-intervention year 1 cohort and the post-intervention year 2 cohort scored significantly higher than the pre-intervention group (mean-difference = .29, p <.05; mean-difference = .72, p < .01, respectively). Also, the post-intervention year 2 cohort statistically outperformed the post-intervention year 1 cohort (mean-difference = .43, p < .01).

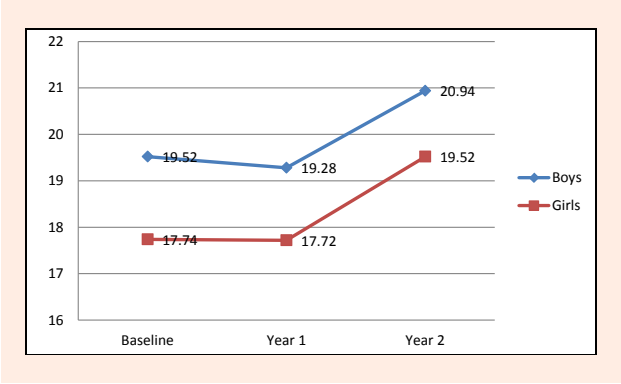

Figure 2. Mean scores of overhand throwing assessments for boys and girls in the three cohorts.

Gender differences in overhand throwing skill competency: Figure 2 presents gender differences of motor skill competency in overhand throwing assessment among three cohorts. For baseline assessment, 738 boys and 659 girls completed the overhand throwing skill test. The boys demonstrated higher than the competent level (M = 19.52, SD = 4.29). In contrast, the girls performed slightly lower than the competent level (M= 17.74, SD = 4.61). The results of t-test indicated that the boys scored significantly higher than the girls (t = 7.46, df = 1341, p < .01).

In the post-intervention year 1, 974 boys and 812 girls participated in the skill assessment. The boys demonstrated higher than the competent level (M=19.28, SD = 3.31). In contrast, the girls demonstrated slightly lower than the competent level (M = 17.72, SD = 3.26). The results of t-test indicated that the boys scored significantly higher than the girls (t = 9.98, df = 1784, p < .01).

In the post-intervention year 2, 795 boys and 701 girls completed the assessment. The boys scored much higher than the competent level (M = 20.94, SD = 3.08). The girls scored quite higher than the component level (M = 19.52, SD = 3.39). The results of t-test indicated a significant mean score difference between the boys and the girls (t = 8.47, df = 1494, p < .01).

Examination of boys' mean score differences on the overhand throwing assessment between three cohorts by means of ANOVA yielded significant differences between the three groups (F = 44.81, df =2, p < .01). The post-hoc Dunnett T3 test indicated that the post-intervention year 2 cohort scored significantly higher than the pre-intervention group (mean-difference = 1.45, p < .01) and the post-intervention year 1 cohort (mean-difference = 1.51, p < .01). However, the post-hoc Dunnett T3 tests revealed no significant difference between the post-intervention year 1 cohort and the pre-intervention cohort (mean-difference = -.38, p > .05).

Examination of girls' mean score differences on the overhand throwing assessment by means of ANOVA yielded significant differences between the three groups (F = 43.57, df =2, p < .01). The post-hoc Dunnett T3 test indicated that the post-intervention year 2 cohort scored significantly higher than the pre-intervention group (mean-difference = 1.80, p < .01) and the post-intervention year 1 cohort (mean-difference = 1.43, p < .01). However, the post-hoc Dunnett T3 tests revealed no significant difference between the post-intervention year 1 cohort and the pre-intervention cohort (mean-difference = .37, p > .05).

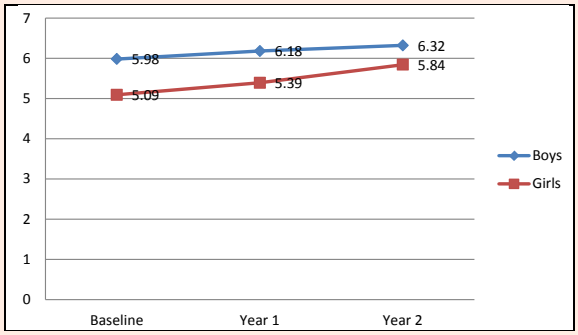

Figure 3. Mean scores of striking assessments for boys and girls in three cohorts.

Gender differences in striking skill competency: Figure 3 presents gender differences of motor skill competency in forehand striking assessment among three cohorts. In baseline assessment, 727 boys and 659 girls completed the test. The boys performed slightly lower than the competent level (M = 5.98, SD = 1.91), but the girls performed lower than the competent level (M = 5.09, SD = 1.91). The results of t-test yielded a significant mean score difference between the boys and the girls (t = 8.63, df = 1372, p < .01). In post-intervention year 1, 717 boys' and 631 girls' skill performance in striking were assessed. The boys performed slightly higher than the competent level (M= 6.18, SD = 1.65). On the contrary, the girls performed lower than the competent level (M = 5.39, SD = 1.52). The results of t-test yielded a significant mean score difference between the boys and the girls (t = 9.127, df = 1346, p < .01). In the post-intervention year 2, 734 boys and 627 girls completed the skill assessment. The boys scored higher than the competent level (M = 6.32, SD = 1.47), while the girls scored slightly lower than the competent level (M = 5.84, SD = 1.49). The results of t-test indicated that the boys score significantly higher than the girls (t = 5.96, df = 1359, p < .01).

Examination of boys' mean score differences on the forehand striking assessment between the three cohorts by means of ANOVA revealed significant differences between the three groups (F = 7.44, df =2, p < .01). The post-hoc Dunnett T3 test indicated that the post-intervention year 2 cohort scored significantly higher than the pre-intervention group (mean-difference = .34, p <

.01). But, the post-hoc Dunnett T3 tests revealed no significant difference between the post-intervention year 1 cohort and the pre-intervention cohort (mean-difference = .19, $p > .05$) and between the two post-intervention cohorts (mean-difference = .15, $p > .05$).

Examination of girls' mean score differences on the forehand striking assessment between the three cohorts by means of ANOVA revealed significant differences between the three groups ($F = 19.09$, $df = 2$, $p < .01$). The post-hoc Dunnett T3 test indicated that both the post-intervention year 1 cohort and the post-intervention year 2 cohort scored significantly higher than the pre-intervention group (mean-difference = .29, p <.05; mean-difference = .72, $p < .01$, respectively). Also, the post-intervention year 2 cohort statistically outperformed the post-intervention year 1 cohort (mean-difference = .43, $p < .01$).

Discussion

This study was designed to examine the fourth- and fifth-grade students' demonstration of motor skill competency in relation to achieving the NASPE content standard 1 as a result of participating in CATCH PE curricular. The results of this study showed that the students in the post-intervention year 1 cohort demonstrated moderately higher than the competent level on the soccer dribbling, passing, and receiving, and overhand throwing skills, but slightly lower than the competent level on the forehand striking skill. More encouraging results were found in the post-intervention year 2 cohort. The students demonstrated much higher than the competent level on the overhand throwing skill, moderately higher than the competent level on the soccer dribbling, passing, and receiving skills, and slightly higher than the competent level on the forehand striking skill. Zhu et al. (2011a) examined levels of fifth-grade students' motor skill competency through conducting a validity study of the PE Metrics assessments. In Zhu et al.'s (2011a) study, 581 students who completed the soccer dribbling, passing, and receiving assessment demonstrated almost one level lower than the competent level ($M = 6.17$, $SD = 2.7$); 172 students who completed the overhand throwing assessment demonstrated slightly lower than the competent level ($M = 17.94$, $SD = 2.58$); 629 students who completed the striking assessment demonstrated the incompetent level ($M = 2.94$, $SD = 1.77$). On the contrary to the study by Zhu et al. (2011a), the results of this study showed much better results regarding demonstration of the competent level or above on the three skills.

Examining the mean score differences of motor skill competency between the three cohorts indicated that the post-intervention year 2 cohort significantly outperformed both the pre-intervention cohort and the post-intervention year 1 cohort on all three skill assessments. The post-intervention year 1 cohort significantly outperformed the pre-intervention cohort on the soccer dribbling, passing, and receiving and the forehand striking assessments, but not on the overhand throwing skill assessment. Similarly, the proportions of the post-intervention year 2 cohort demonstrating the competent level or above were higher than those of the pre-intervention cohort and the post-intervention year 1 cohort on all three skills assessments. The proportions of the post-intervention year 1 cohort reaching the competent level or above were higher than those of the pre-intervention cohort on soccer dribbling, passing, and receiving and the forehand striking assessments, but not higher than the overhand throwing skill assessment.

While heredity and growth influence skill development and learning, sequential learning tasks and productive learning environment contribute to motor skill development in children (Clark, 2005; Gallahue and Ozmun, 2006; NASPE, 2004; Rovegno and Bandhauer, 2013). The results of this study might be associated with the PE teachers' implementation of CTACH PE curricular during PE lessons. During the PEP project year 2 (the post-intervention year 1), the PE teachers on average taught 51% of PE lessons using the CATCH PE curricular. As the PE teachers taught more CATCH PE lessons (77%) during the PEP project year 3 (the post-intervention year 2), the students in the post-intervention year 2 cohort performed significantly better than the students in the post-intervention year 1 cohort on all three skills. The CATCH PE curricular provides students with developmentally appropriate physical education content which maps most of the essential content addressed by the NASPE content standards. The instructional practices of the CATCH PE are associated with maximizing time on task and learning opportunities, increasing MVPA in physical education class, and providing students with congruent and specific feedback about their motor performance. Corroborating with previous studies (Beurden et al., 2003; McKenzie et al., 1998), this study indicates that implementation of a quality physical education program contributes to students' demonstration of motor skill competency in the three manipulative skills. This study suggests that to better equip young children with motor skill competency in sport-related skills, PE teachers should intentionally use CATCH PE curricular or compatible curricular to teach children sport-related skills in sequentially progressive ways and various game-like and modified game contexts. This study evidences that a well-designed curriculum intervention can significantly enhance motor skill competency among young children (Beurden et al., 2003; McKenzie et al., 1996; 1998; 2003).

It is important to note that in this study the highest number of students (80%) who demonstrated the competent level or above is the overhand throwing skill, followed by the soccer dribbling, passing, and receiving skills (75%) in the post-intervention year 2 cohort. However, the lowest number of students (64%) in the post-intervention year 2 and (56%) in the post-intervention year 1 demonstrated the competent level is forehand striking skill. Forehand striking skill is a basic specialized manipulative skill used in tennis, pickle ball, and badminton. Mastery of striking skill in childhood lays a foundation for adolescents to effectively learn and master related skills and to successfully play these sports. Barnett et al. (2009) found that manipulative skill proficiency developed in childhood rather than locomotor skill proficiency

seemed to be a significant determinant for adolescents to engage in moderate-to-vigorous activity and organized activity. Okely et al. (2001) reported that highly skilled adolescents spent more time in organized physical activity than low skilled adolescents. This study suggests that physical education teachers should devote more time to help elementary school students learn striking-typed skills. Physical education teachers need to help students use the striking-typed skills in game-like and modified-game situations to reinforce their skill acquisition and improve their skill competency.

This study shows that the boys in the pre-intervention and the two post-intervention cohorts scored significantly higher than the girls on all three skill assessments. Likewise, McKenzie et al. (1998) reported that the girls' total skill scores on overhand throwing, catching, and kicking at baseline and at the end of intervention were 41% to 43% lower than the boys' scores. Similarly, Erwin and Castelli (2008) also noted that the boys performed significantly better than the girls on the overhand throwing skill. Barnett et al. (2009) found that boys were more proficient at manipulative skills than girls. The gender differences on the three manipulative skills might be related to environmental influences (Okely et al., 2001; Wrotniak et al., 2006). Team sports like baseball and soccer are more popular among boys than girls. Participation in these team sports may be considered more socially acceptable for boys, but more socially unacceptable for girls. Due to the social environment influences, boys may have more opportunities to participate in these games. Therefore, they may have more opportunities to practice and refine the manipulative skills widely used in playing these games.

Although gender differences in the three skills were found at baseline and the two post-interventions, it was promising to find that the girls in the post-intervention year 2 cohorts had substantial improvement in all three skills, compared to the girls in the post-intervention year 1 cohort. The most dramatic gain for the girls in the post-intervention year 2 cohort is the overhand throwing skill and followed by the soccer dribbling, passing, and receiving skills. The girls in the post-intervention year 1 cohort had a modest improvement in all three skills, compared to the girls in the pre-intervention cohort. It is also noted that while the girls showed improvement in the forehand striking skill from the pre-intervention, the post-intervention year 1, to the post-intervention year 2, the girls in the two post-intervention cohorts demonstrated lower than the competent level on the tennis striking skill assessment. Okely et al. (2001) found that time spent in organized physical activity was more strongly associated with skills in girls than in boys. Further, they noted that only girls who are highly proficient at a sport will continually participate in that sport during adolescence, while other girls with poor skills may quit or decrease their participation in a sport. Given the important role of motor skill competency in participation in organized sports and physical activity, this study suggests that physical education teachers need to focus more efforts on improving girls' basic specialized manipulative skills used in playing team and individual sports. While teaching these sports to their students, physical education teachers should provide girls with more specific and performance related feedback and also use appropriate teaching strategies to involve girls in playing an important role during game plays. Providing supportive gender-specific learning environment is instrumental to reducing gender differences in motor skill competency (Beurden et al., 2003).

Implications

This study adds to literature on standards-based assessment in physical education settings. This study indicates that the PE Metrics assessment rubrics are feasible tools for physical education teachers to assess levels of students' demonstration of motor skill competency during a regular physical education lesson. This is the first study of using the PE Metrics assessment rubrics to assess students' motor skill competency in basic specialized skills for three consecutive years within the context of the physical education teachers' implementation of CATCH PE curricular. To date, no research has attempted to examine how standards-based quality physical education curricular help students' achieving the NASPE content standard 1. The results of this study show that the students significantly improved their manipulative skill competency over the course of three years as a result of participating in a well-designed curriculum intervention. This study suggests that CATCH PE are effective curricular used for future intervention programs aiming to improve students' motor skill competency in relation to physical activity promotion among school-aged children.

Conclusion

In conclusion, the results indicated that while heredity and growth are associated with motor skill development, CATCH PE was conducive to improving fourth- and fifth-grade students' motor skill competency in the three manipulative skills. The post-intervention year 2 cohort performed significantly better than both the pre-intervention cohort and the post-intervention year 1 cohort on all three skills assessments. The post-intervention year 1 cohort significantly outperformed the pre-intervention cohort on the soccer dribbling, passing, and receiving and the forehand striking assessments, but not on the overhand throwing skill assessment. Also, the post-intervention year 2 cohort showed higher proportions of the students reaching the competent level or above on all three skills assessments, compared to the post-intervention year 1cohort. Similarly, the post-intervention year 1 cohort had higher proportions of the students demonstrating the competent level or above than the pre-intervention cohort on the soccer dribbling, passing, and receiving and the forehand striking assessment, except for the overhand throwing skill assessment. While the boys in the three cohorts significantly outperformed the girls in the three cohorts on all three skills assessments, the girls showed substantial improvement on the overhand throwing and the score skills. However, the girls, in particular, need to improve motor skill competency in the forehand striking skill.

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Key points

- CATCH PE is an empirically-evidenced quality PE curricular that is conducive to improving students' manipulative skill competency.
- Boys significantly outperformed than girls in all three manipulative skills.
- Girls need to improve motor skill competency in striking skill. PE Metrics are feasible assessment rubrics that can be easily used by trained physical education teachers to assess students' manipulative skill competency.

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