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Knowledge in Action: Fitness Lesson Segments That Teach Health-Related Fitness in Elementary Physical Education

Michael G. Hodges

William Paterson University

Pamela Hodges Kulinna

Arizona State University

Hans van der Mars

Arizona State University

Chong Lee

Arizona State University

The purpose of this study was to determine students' health-related fitness knowledge (HRFK) and physical activity levels after the implementation of a series of fitness lessons segments called Knowledge in Action (KIA). KIA aims to teach health-related fitness knowledge (HRFK) during short episodes of the physical education lesson. Teacher participants from one district ($N = 10$) were randomly assigned into either the intervention or comparison group. Intervention teachers used the KIA fitness lessons during fifth grade students' physical education classes. These teachers received training sessions, teaching materials, and YouTube videos that modeled the KIA fitness lessons. Intervention fidelity was assessed through observations and a fidelity checklist. Students' physical activity levels were measured using accelerometers and HRFK was examined by PE Metrics 28-question pencil and paper test. General linear models (GLM) and Hierarchical linear models (HLM) were used to examine group differences. Intervention students had a 3.4 (20%) greater unit improvement in HRFK scores when compared with their comparison counterparts ($p < .001$), at the school level. Student activity levels of moderate-vigorous physical activity (MVPA) time were similar in both groups ($p = .64$). Teachers can use the KIA fitness lesson segments or similar strategies to effectively teach HRFK in elementary physical education classes.

Keywords: PE Metrics, primary, cognitive, teacher effectiveness

Schools are considered to be ideal settings for the promotion of physical activity (CDC, 2011; McKenzie, 2007; Pate et al., 2006). However, in most U.S. public schools, children and adolescents are experiencing a reduction in physical activity opportunities due to an increase in academic achievement (NASPE, 2012; Trost

& van der Mars, 2010). In fact, according to the Centers of Disease Control and Prevention ([CDC], 2010), only 4% of elementary, 8% of middle, and 2% of U.S. high schools offer daily physical education. This reduction in physical activity contributes to the already existing struggles of achieving the recommended 60 min of health-enhancing physical activity a day. This raises concern, as physical activity serves as an important preventative function against many health-related diseases.

One method for getting students active during school hours is through quality physical education. In order for physical education programs to be successful, programs ought to encourage regular participation in physical activity, teach motor skills, and provide the requisite health-related fitness knowledge (HRFK) needed to pro-

Hodges is with the Department of Kinesiology, William Paterson University, Wayne, NJ. Hodges Kulinna and van der Mars are with the Department of Physical Education, Arizona State University, Mesa, AZ. Lee is with the Department of Nutrition and Health Promotion, Arizona State University, Phoenix, AZ. Address author correspondence to Michael Hodges at hodgesm1@wpunj.edu.

mote the adoption of a physically active lifestyle (Rink & Hall, 2008). Unfortunately, it has been documented that physical education programs are not providing sufficient HRFK instruction (Hopple & Graham, 1995). Students of all ages; elementary, secondary, and college students have shown low levels of HRFK (Brusseu, Kulinna, & Cothran, 2011; Castelli & Williams, 2007; Desmond, Price, Lock, Smith, & Stewart, 1990; Keating et al., 2010; Keating, Chen, Guan, Harrison, & Dauenhauer, 2009; Kulinna, 2004; Miller & Berry, 2000; Stewart & Mitchell, 2003). Therefore, one may conclude that physical education teachers are simply not providing a sufficient amount of HRFK.

Research supports the correlation between HRFK acquisition and an increase in daily physical activity (Dale & Corbin, 2000; DiLorenzo, Stucky-Ropp, Vander Wal, & Gotham, 1998; Liang et al., 1993). Several researchers have specifically examined this link and a number of important health-related variables. For example, Ferguson and colleagues (1989) conducted a study examining the connection between HRFK and physical activity among middle school students' ($N = 603$). Researchers also examined their attitudes toward physical education, knowledge of exercise and their beliefs about one's abilities. It was found from multiple-regression analyses that perceived (knowledge of) benefits of exercise, along with attitudes and beliefs about one's ability levels were foretelling on student's intention to exercise and exercise behaviors. Liang and colleagues (1993) examined the relationship among medical students' ($n = 131$) knowledge and feelings toward health and exercise and their respective fitness levels. By testing participants VO_{2max} and HRFK, researchers found that students' knowledge and attitudes toward health promotion and exercise were predictive of their fitness levels (Liang et al., 1993). This is noteworthy as researchers concluded that knowledge played a role in participants' physical activity engagement, which ultimately may affect ones fitness levels. Thompson and Hannon (2012) found similar results when they investigated the relationship of HRFK to physical activity in high school students from the Southwestern United States. A self-report Physical Activity Questionnaire for Adolescents (Kowalski et al., 1997) was used to assess students' physical activity and a 100-point pen and pencil exam used to test their HRFK. Results showed a moderate positive correlation between HRFK and physical activity. Post hoc comparisons of HRFK were conducted across categorical levels of physical activity (high, medium, low), which indicated that students from the low physical activity group reported significantly less HRFK and participants engaging in more physical activity scored higher on the HRFK test (Thompson & Hannon, 2012). Lastly, DiLorenzo and colleagues (1998) conducted a two-phase longitudinal (two-year) study examining the determinants of physical activity among elementary students. In this study, researchers initially solicited families who had children in the fifth or sixth grade by telephone using Physical Activity Interview (PAI), an instrument that estimates a child's exercise

behavior (Baranowski, 1988). Fifth and sixth grade students' step-wise regression results indicated that exercise enjoyment was a significant predictor of physical activity; however, at Phase two (three years later), families were interviewed again as the students were eight and ninth graders and step-wise regression results indicated that boys exercise knowledge was the only predictor to physical activity.

Researchers have examined intervention programs aimed to increase HRFK in schools. For example, Palmer, Graham, and Elliot (2005) looked into increasing students' knowledge through a web-based health program. Researchers found that the 5th grade students' HRFK could be significantly increased through a sound web-based program, which was also seen to positively affect participants' attitudes toward physical activity. Another intervention study conducted by Manios, Kafatos, and Mamalakis (1998), examined the implementation of a school and home based intervention program, called 'Know Your body'. This program was directed to both first grade students and their parents for six years. Researchers provided curricular materials related to healthy behaviors to teachers and to children's parents. Authors reported significantly greater improvements in HRFK among the implementation groups' students and their parents as well as an increase in students' out of school physical activity. The idea of including parents in student-based programs has been found to significantly improve the effectiveness of a school program and elementary aged students' HRFK (Hopper et al., 1996). Lastly, Dale, Corbin, and Cuddihy (1998) examined the implementation of a Conceptual Physical Education (CPE) program during Project Active Teens, which targeted increasing knowledge through classroom discussions and curricula focused on lifetime activities in high school-aged youth. After the first year of implementation, it was found that 9th grade boys in the CPE program were more active during their leisure time as compared with students from the Traditional Physical Education and the comparison group, which students were not engaging in physical education classes (Dale et al., 1998). It is important to mention that the current program, as well as the others stated above have attempted to teach and improve students' HRFK, however this has largely occurred outside the physical education class setting. In the current education climate, with a focus on common core subject areas, it may be challenging for schools to dedicate more time to physical education. Therefore, it may be advantageous for programs to adopt strategies to achieve HRFK concurrently with other physical education outcomes goals.

Cognitive Mediation Theory

When creating novel class programs or teaching strategies it is important to consider the factors that affect student learning. The Cognitive Mediation Theory is one theory that explains and describes the link between teacher

behavior and student learning as indirect, with mediating factors contributing to the learning process (Doyle, 1977). According to this theory, for students to profit from instruction they must be actively engaged. Therefore, the role of the teacher as described, moves from exclusive instruction, to facilitation, and the creator of an effective learning environment.

Chen (2001) investigated student interest, specifically motivation during instructional units in physical education. Results indicated that if activities were novel, cognitively challenging, and offered immediate enjoyment, then students were more likely to be engaged. Chen (2001) concluded that a deeper understanding of learning objectives could be reached when motivation and student interest levels are high. Lee, Fredenburg, Belcher and Cleveland, (1999) further examined this theory specifically looking at students and their perceptions of gender orientated activities. Authors found that student conceptions of confidence and motivational beliefs were driven by the gender appropriateness of the activities (i.e., basketball is for boys and dance is for girls). This misconception was seen to inhibit student learning potential. Byra and Jenkins (1998) examined the role of the environment and how offering choices in activities affected students in physical education classes. In this study, researchers offered students the opportunity to select different activities, which had different levels of task difficulty. It was possible that students would enjoy the ability to choose from the listed tasks, working at their own pace rather than being told exactly what task to complete. It was concluded by the researchers that students' decisions were mostly based upon perceived success and the challenge of the task at hand, possibly influencing students' competency level (Byra & Jenkins, 1998). The last cognitive mediating factor researched was self-efficacy and the role self-efficacy has on skill acquisition. Constructed by Solmon and Lee (1996), they looked at 6th grade students' self-efficacy during a four-day instructional unit on the forearm pass skill in volleyball. Results indicated that students with low self-efficacy toward hitting the forearm pass were unlikely to exert effort during practice since they viewed the possibility of success as unrealistic.

This theory highlights mediating factors present in school settings that can either enhance or inhibit student learning. Therefore, Cognitive Mediation Theory served as the Theoretical Framework for this study and the development of the activities by identifying the factors (i.e., student interest and motivation, self-efficacy, gender appropriateness, and various environmental influences) associated with student learning in the physical education setting.

The purpose of the current study was to investigate the effectiveness of the Knowledge in Action (KIA) fitness lesson segments on HRFK (i.e., a student learning outcome) among fifth grade students in physical education. KIA fitness lesson segments were deemed effective if HRFK was significantly better, while physical activity participation levels did not significantly change among

participating groups. Therefore, two specific research hypotheses guided this study: (a) the classes randomized to the KIA group will have significant higher HRFK than those in the comparison classes at posttest, and (b) the physical activity levels of students in KIA classes will not significantly differ from students in the comparison classes.

Methods

Participants and Setting

The study was conducted in one large suburban school district that consists of 25 elementary schools, six junior high schools, four high schools, three alternative schools, and five traditional academies. To test the research hypothesis, five intervention and five comparison schools were randomly assigned from schools interested in participating. Students from the assigned schools all received physical education twice every sixth school day for 30 min each. Institutional Review Board approval was obtained from the University and the School District. Parents and teachers provided consent, while students gave assent for participation.

Teacher Participants. Physical education teachers were recruited via e-mail, phone, or in-person. Once 10 physical education teachers were recruited, they were randomly placed into either the comparison or the intervention group. Three intervention teachers ($n = 8$ classes; $n = 145$ students) and two comparison teachers ($n = 6$; $n = 102$ students classes) were randomly selected to use accelerometers and assess student physical activity levels during class time. The physical education teachers' years of teaching experience ranged from 5 to 27 ($M = 11.83$, $SD = 6.56$). Nine of 10 physical education teachers were Caucasian, while one was Hispanic.

Student Participants. Fifth grade students participated in this study. There were a total of ($N = 30$) class groups with ($N = 633$) students. Students' demographics can be seen in Table 1. The intervention group ($n = 17$; class groups) contained ($n = 331$; 166 boys and 167 girls) students with the age range of 9–11 ($M = 10.07$, $SD = 0.42$) and the comparison group ($n = 13$; class groups) contained ($n = 302$; $n = 144$ boy and $n = 158$ girls) students with the age range of 9–12 ($M = 10.14$, $SD = 0.48$).

KIA Fitness Lesson Segments. Cognitive Mediation Theory framed the development of the KIA fitness lesson segments. Some KIA activities were informed by the *Physical Best Activity Guide* (NASPE, 2005) and *Dynamic Physical Education Elementary* (DPE; Pangrazi & Beighle, 2013) curricular models, however the concepts and design was adjusted to consider mediating factors that affect student learning and incorporated HRFK structure.

The KIA fitness segments were designed to last no more than 12 minutes, which contains a brief descrip-

Table 1 Students' Ethnicity and Rate of Free and Reduced Lunch Rates by School

Intervention Teachers	Caucasian	Hispanic	African American	Asian American	Free/Reduced Lunch
Brad	35.7	42.9	12.5	7.1	51.52
Mike	58.2	17.9	16.4	6.0	16.70
Ruth	53.8	21.8	9.2	21.0	3.65
Jessica	78.1	9.4	0.0	12.5	15.48
Gabby	47.4	29.8	7.0	14.0	16.76
Total (Mean)	54.64	24.36	9.02	12.12	20.82

Comparison Teachers	Caucasian	Hispanic	African American	Asian American	Free/Reduced Lunch
Larry	63.6	13.6	15.9	2.3	16.70
Abby	49.2	16.4	21.3	9.8	13.24
Jessie	63.8	8.5	10.7	10.06	9.26
Jillian	0.00	87.1	11.4	0.00	93.88
Steven	63.7	15.1	11.3	6.3	21.4
Total (Mean)	48.06	28.14	14.12	5.692	30.896

Note: All values are in percentages

tion of activities (1–2 minutes), four 1 minute and 45 seconds KIA activities (7 minutes), and three 30-second transitions between stations (1 minute and 30 seconds). Each KIA lesson contains four different KIA activities that were positioned in each corner of the playing area. The KIA fitness lesson segments are on a rotating lesson design. For example, if (Lesson 1) had activities, “W,” “X,” “Y,” and “Z,” the following lesson (Lesson 2) would include a new activity “A” in place of the first activity “W.” This results in activities, “X,” “Y,” “Z,” and “A.” This pattern was continued so that students were exposed to each activity four times during the seven-lesson series. The KIA activities were developed to provide students with choices to facilitate students' ability to work at their own pace, increase self-efficacy, cognitively challenge students, and increase students' motivation through novel fitness activities.

Intervention

The intervention physical education teachers implemented the KIA fitness during the fitness segment of their 5th grade physical education classes. See Table 2 for a description of all KIA fitness activities. Teacher participants were provided with YouTube videos demonstrating the KIA 12 minutes lessons, as well as all needed station signs, lesson plans, and needed equipment to teach the KIA fitness lesson segments.

Teachers were encouraged to play a preset music mix of 1 minute and 45 seconds activity sessions with 30 seconds of silence for station transition purposes. The music served as a motivator for students during physical activity and a guide for teachers, supporting uniformity. During the 30-second transitions, instructors were encouraged to

check for student understanding with a quick question on one of the concepts being taught during that lesson. Each fitness activity contained signage, which offered directions on how to engage in the activity as well as taught the specific concepts for that particular activity.

Comparison classes did not receive the KIA fitness lesson segments and were asked to not alter their instruction. Therefore, comparison teachers continued to teach from the adopted curriculum, *DPE* (Pangrazi & Beighle, 2013). The DPE curricular model follows a four-part lesson plan, beginning with a brief, highly active introductory activity, followed by a fitness segment (both parts completed within the first 12–15 minutes). The fitness segment is followed by a lesson activity that focuses on skills or various activities, and finally, the fourth part of the lesson is a culminating activity or game focusing on the skills previously taught.

Procedures

The duration of the study was seven weeks, with 2 weeks allocated for knowledge testing (pre and post). During the testing weeks, members of the research team traveled to each school and administered the pre and post exams following a specific protocol. Each test question and the corresponding answer options were read to students, giving students approximately 20–30 seconds wait time for each question.

Randomly selected students' from the intervention ($n = 8$ classes; $n = 145$ students) and comparison ($n = 6$ classes; $n = 102$ students) were asked to measure their physical activity levels using accelerometers. Students arrived to their respective physical education class and immediately placed their assigned NL-1000 accelerometers just above

Table 2 Description of KIA Fitness Lesson Segments

1. Scavenger Hunt: Students are to get with a partner and follow the provided map to hunt for different exercises scattered somewhere around the teaching area. Once the activity was found, students perform the task provided. 2. Body Composition Avengers: Students are divided and positioned at opposing hula-hoops spaced approximately 20ft apart. The hoops contain 6 yellow (fat) and 6 red bean bags (muscle). Students run and grab 1 red bean bag at a time and bring it back to their hoop. Students' can also grab a fat bean bag from their hoop and run and place it in the other teams hoop. Get more red bags and win. 3. Take your Heart Rate: Students immediately choose either a moderate (i.e., walking, playing catch) or vigorous (i.e., jump roping, or agility run) activity that is positioned at the station. Students are to engage in their chosen activity for half the duration of the station then check their heart rate then switch to the other activity. 4. Benefit Surprise: Students will grab one benefit card from several that are scattered face down inside a hula-hoop. Each card has a benefit and an activity to perform. Once the student reads the benefit card he or she is to put the card back face down and perform the activity. Once completed the student will go and grab another activity and continue this process as many times as they can. 5. Roll the Dice: Students quickly begin by rolling the big foam dice. If the dice lands as an odd number, the roller decides from either an aerobic or muscular endurance exercise. If the dice lands on an even number, the roller chooses a weight bearing or flexibility exercise. 6. Bearing the Weight: Students are to read the sign (task sheet) and perform the task listed. All activities listed on the sign are weight bearing type activities (i.e., sit-ups, performing a softball pitch, wall jumps). Further concepts regarding weight-bearing activities were offered on the sign provided. 7. Quiz your Partner: Students are to partner up and walk while reading and quizzing each other from the given question on the cards.

the right hip on their waistband. After completion of the KIA fitness lesson segments or after 15 minutes for the comparison group, accelerometers were removed and a trained research team member documented students' step count and time in MVPA. As explained before, there were minimal pedagogical differences between the comparison and intervention classes. Comparison classes engaged in an introductory activity followed by a fitness activity aiming to enhance all five health-related fitness components, an analogous expectation and design to the intervention classes first 15 minutes.

Any unusual numbers were discussed with students immediately to ensure that accurate data were reported. The research members cleared the accelerometers after data collection in preparation for subsequent lessons.

Data Collection

HRRFK Assessment. NASPE has endorsed the PE Metrics (NASPE, 2010), which was used to examine HRRFK in the current study. More specifically, the research team used the Standards 3 & 4, fifth grade student instrument that contains 28 multiple-choice items. Twenty-eight items were categorized into eight performance descriptors, which were categorized by PE Metrics developers. The authors' used the descriptors to align activities developed for the KIA fitness lesson segments with the content assessed on the PE Metrics exam. Descriptors were identified as: (a) chooses to be physically active outside of school, (b) describes personal responses to physical activity, (c) describes characteristics of health-enhancing physical activity, (d) achieves criterion-reference standards, (e) identifies personal

health-related weaknesses/strengths, (f) describes how to improve personal fitness, (g) identifies the principles (guidelines) associated with improving physical fitness, and (h) identifies specific benefits associated with each component of health-related physical fitness. One sample item from the PE Metrics under the performance descriptor of "describes personal responses to physical activity" with the item "when you exercise vigorously" with the response options of: (a) you start to breathe more slowly, (b) your heart keeps a slow, steady rhythm, (c) it is more difficult to find your pulse, or (d) you increase your pulse.

The PE Metrics assessments that consist of written tests were validated previously (Zhu et al., 2011). No other studies could be found that have used this PE Metrics knowledge assessment addressing NASPE Standards 3 and 4 beyond the validation studies.

Physical Activity Level Assessment. The New Lifestyles NL-1000 accelerometers were used to assess students' physical activity levels. The NL-1000 detects the maximum acceleration over each 4-second epoch, and categorized into one of 11 activity intensity levels. There was an on-board keypad and screen display, which offered an output of activity time and steps. Hart, Brusseau, Kulinna, McClain, and Tudor-Locke (2011) have validated the NL-1000 for the use of 10–11 year old children. The research team used the accelerometer count cutoffs of 5–9, to designate MVPA range, as this was previously used during the validation (Hart et al., 2011).

Intervention Fidelity Checklist. The intervention fidelity checklist used for this study included seven dichotomous scale items (i.e., whether the KIA

segments were implemented and if activities were timed appropriately), which documented group adherence and examined instruction of the KIA fitness lesson segments. Time intervals were documented for each component of the lesson, as this was an integral part of the KIA segments (i.e., duration of entire lesson and duration of teacher initial explanation of the activities). Research members were trained on the KIA fitness lesson segments. All research members met with the lead researcher and observed video recordings on the KIA lessons, and described how to accurately evaluate the teachers on each of the scaled items. Observations occurred for the entire duration of the KIA lesson. Comparison classes were also observed to confidently determine comparison teachers were not using any form the KIA fitness lesson segments.

Data Analysis

Descriptive statistics (M , SD) were calculated across gender and treatment (i.e., intervention and comparison) categories for HRFK test scores and physical activity levels. Similar analyses were conducted on teacher fidelity data. General linear models with Scheffe's post hoc tests were used to test mean difference for change in HRFK (HRFK Δ), steps and time in MVPA between intervention and comparison groups after adjustment for gender.

Cronbach α coefficients were used to estimate the internal-consistency reliabilities for the HRFK pretest and posttest scores overall and by subgroup (i.e., dividing odd and even assessments and also looking at two groups).

Hierarchical linear models (HLM), at school level (level-2), were used to compare mean differences for changes in HRFK between intervention and comparison groups after adjustment for gender and gender*treatment interaction. The two-level multilevel models are as follows:

$$\text{Level 1: } \text{HRFK}\Delta = \beta_{0j} + \beta_{1j}(\text{Sex}) + e_{ij},$$

where $i = 1, 2, \dots, \text{students}$, $j = 1, 2, \dots, \text{schools}$.

$$\text{Level 2: } \beta_{0j} + \gamma_{00} + \gamma_{01}(\text{Intervention vs. Comparison}) + u_{0j}$$

$$\beta_{1j} + \gamma_{10} + \gamma_{11}(\text{Intervention vs. Comparison})$$

Full model (Model 1):

$$\text{HRFK}\Delta = \gamma_{00} + \gamma_{01}(\text{Intervention vs. Comparison})$$

$$+ \gamma_{10}(\text{Sex}) + \gamma_{11}(\text{Intervention vs. Comparison})(\text{Sex})$$

$$+ u_{0j} + e_{ij}$$

Baseline mean difference for the HRFK scores between intervention and comparison groups was significantly different ($p < .001$). Thus, we also tested intervention effects after adjustment for the baseline HRFK scores in the following full model (Model 2).

$$\text{HRFK}\Delta = \gamma_{00} + \gamma_{01}(\text{Intervention vs. Comparison})$$

$$+ \gamma_{10}(\text{Sex}) + \gamma_{11}(\text{Intervention vs. Comparison})(\text{Sex})$$

$$+ \gamma_{02}(\text{Baseline HRFK}) + u_{0j} + e_{ij}$$

The covariance parameter estimates for the random effects (μ_{0j} , e_{ij}) were tested to examine the statistical significance of intercepts (τ_{00}) and slopes (τ_{11}) across schools. Intraclass correlation coefficients (ICC), $\rho = \tau_{00} / (\tau_{00} + \sigma^2)$, were also computed to estimate the proportion of total variance between schools, intervention, and comparison groups. We also examined mean difference for time in MVPA between intervention and comparison groups at school level (level-2) using model 1.

All statistical procedures were performed using SAS PROC Mixed models by Statistical Analysis Systems software (SAS Institute, Cary, NC). All p -values were two-tailed, and values of less than 0.05 were considered to indicate statistical significance.

Results

After the exclusion of 76 participants (e.g., missing pretest or posttest values or covariates), participants included 633 students ($n = 331$ intervention; $n = 302$ comparison) who were enrolled in the five intervention and five comparison schools.

Teacher Fidelity

There were a total of 128 observations, 80.6% of all KIA fitness lessons, were observed during the intervention. Intervention physical education teachers took on average 12.49 minutes to complete the KIA fitness lesson segments (goal was 12 minutes). Based on field notes, teachers were witnessed taking more time explaining activities, and dealing with management during the 30-second transitional period. Total mean percentage of teachers implementing all components of the KIA fitness lesson segments totaled 77.9%. Although all teachers were observed teaching the segments in some fashion, a few teachers were witnessed missing one or more components of the KIA lesson segments (e.g., introduction of new concepts, checking for understanding during transitions, closure at the end of the lesson). Moreover, certain teachers were observed lacking a complete understanding of particular concepts taught (i.e., methods on how to improve personal fitness or proper identification of weight-bearing activities).

Comparison teachers were not documented using the KIA fitness lesson segments in anyway. Comparison teachers were documented to incorporate HRFK instruction, however this occurred infrequently. Teachers were observed upholding their previously planned unit and lessons from the *DPE* model, which started with an introductory activity followed by a fitness segment.

Health-Related Fitness Knowledge (HRFK) Results

Descriptive statistics (M , SD) for the HRFK scores across gender and treatment (intervention vs. comparison) categories are presented in Table 3. The Cronbach α coefficients for the pretest and posttest HRFK questionnaires

were 0.67 and 0.74, respectively, indicating that acceptable levels of internal consistency were reached.

According to GLM results, as shown in Table 3 (student-level), students in the intervention group had a 3.1(20%) greater mean improvement in HRFK than did students in the comparison group ($\Delta = 0.6[5\%]$, adjusted for gender, ($p < .001$). Boys in the intervention group had a greater improvement in HRFK ($\Delta = 3.4[22\%]$) compared with their comparison counterparts ($\Delta = 0.8[6\%]$) (p

$< .001$). Girls in the intervention group also had a greater improvement in HRFK ($\Delta = 2.8[18.3\%]$) than did their comparison counterparts ($\Delta = 0.5[4\%]$) ($p < .001$). See Figure 1 for students' pre and post HRFK means for each intervention and comparison teacher.

Estimated parameters and standard errors for the fixed and random effects for models 1 and 2 are shown in Table 4 (level-2). Students in the intervention group had a 2.5(16%) greater mean improvement in HRFK

Table 3 Descriptive Statistics ($\bar{X} \pm SD$) for HRFK Scores Across Gender and Treatment

Variable	Intervention				Comparison				P-value
	n	Pretest	Posttest	Δ	n	Pretest	Posttest	Δ	
Boys ($n = 324$)	166	15.57 (3.78)	18.99 (3.84)	3.4	158	12.94 (3.97)	13.74 (3.94)	0.8	<0.001
Girls ($n = 309$)	165	15.33 (4.13)	18.16 (4.18)	2.8	144	13.69 (3.37)	14.17 (3.59)	0.5	<0.001
Total ($n = 633$)	331	15.45 (3.96)	18.58 (4.03)	3.1	302	13.30 (3.71)	13.94 (3.77)	0.6	<0.001

Note. Δ = posttest-pretest.

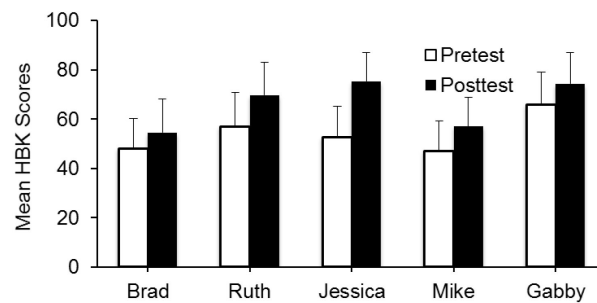


Figure 1 — Physical Education Teachers' Class HRFK Mean Score Comparison.

Table 4 Estimated Effects of KIA on Changes in HRFK in the Fifth Grade Students

	Model 1			Model 2		
	Estimate	SE	P-value	Estimate	SE	P-value
Fixed-Effect Parameter						
Intercept (γ_{00})	0.9005	0.40	0.042	0.3734	0.48	0.454
Treatment (γ_{01})	2.5135	0.57	<0.001	3.4418	0.68	<0.001
(Int vs. Comp.)						
Gender (γ_{10})	-0.3443	0.35	0.33	-0.048	0.32	0.88
(Female vs. Male)						
Treatment * Gender	-0.0941	0.49	0.69	-0.5745	0.44	0.19
Baseline HRFK				-1.4650	0.12	<0.001
Covariance Parameter						
$\sigma^2_{\text{school}} (\tau_{00})$	0.5014	0.3110	0.054	0.9078	0.4732	0.028
$\sigma^2_{\text{Intervention}}$	9.4162	0.7388	<0.001	7.4791	0.5865	<0.001
$\sigma^2_{\text{Comparison}}$	9.3161	0.7638	<0.001	7.6038	0.6235	<0.001
$\sigma^2_{\text{Residual}}$	9.3684	0.5312	<0.001	7.5388	0.4273	<0.001

than did the comparison group students after adjustment for gender and gender*treatment interaction ($p < .001$) (model 1). There were no statistical differences by gender ($p = .33$) or cross-level interaction (treatment*gender) ($p = .69$) (model 1).

We also assessed the effect of the intervention after further adjustment for baseline HRFK scores. As shown in Table 4 (model 2), similar findings were observed as in model 1 after further adjustment for baseline HRFK scores (p value for the treatment by HRFK interaction was 0.51 in which ANCOVA assumption was justified that students in the two groups were not significantly different in terms of knowledge). Students in the intervention group had a 3.4 item (22%) improvement of HRFK scores when compared with their comparison counterparts ($p < .001$) (model 2).

Descriptive statistics were also conducted on each specific item identifying a range of positive results. Most items were found from pre to post test results to increase approximately 15–51%, with the most significant improvement found in the performance descriptor, 'Chooses to be Physically Active Outside of School'. Students' posttest scores for items 10 and 11, found in the performance descriptor 'Describes Characteristics of Health-Enhancing Physical Activity,' were documented an average success rate of 11% and 8%, respectively. This was observed to be a small increase from the pretest results of 3% and 6%.

The variance of the random effects associated with the intercept for schools was 0.91 (model 2). The intra-class correlation coefficient (ICC) for schools, $\sigma^2_{\text{school}} / (\sigma^2_{\text{school}} + \sigma^2)$, was 0.11 indicating that approximately 11% of the total observed variance in changes in HRFK was explained by school mean differences (i.e., minimum differences in variance among the schools). Approximately 89% of the variance is attributable to differences between intervention and comparison students within their schools. The ICCs for intervention and comparison groups were 0.108 and 0.107, respectively, indicating minimal differences in variance among the schools across intervention and comparison groups.

Physical Activity Measures

Students ($n = 145$) in the intervention group had more steps ($M = 871.20$, $SD = 140.15$) than students ($n = 102$) in the comparison group ($M = 762.38$, $SD = 158.52$) ($p < .001$). According to descriptives, students from the intervention group were engaging in approximately 72 steps per minute compared with the intervention students who averaged 63 steps per minute. During the KIA fitness lesson segments, students in the intervention group spent more time in MVPA ($M = 3.78$, $SD = .89$) than the students in the first 15 min of the comparison group ($M = 3.25$, $SD = 1.17$) ($p < .001$). See Figure 2 for the comparison of mean steps across the seven lesson segments.

At level-2, HLM analysis on mean difference for MVPA was also tested across groups as assessed by accelerometer between intervention and comparison groups. Although students in the intervention group had an overall

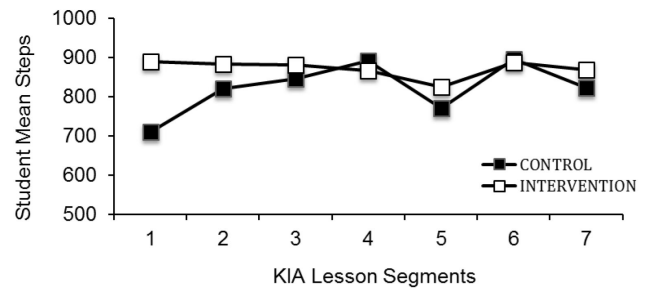


Figure 2 — Students' Mean Step Count Across each KIA Lesson Segments.

average of 0.6 min more of MVPA, there was no statistical difference between intervention and comparison groups ($p = .33$) in MVPA time when confounding variables were considered (level-2).

Discussion

Fox and Biddle (1998) explained that HRFK is important and provides individuals with a foundation for intelligent decision-making. Unfortunately, students of all ages have documented low levels of HRFK (Brusseau et al., 2011; Hopple & Graham, 1995; Kulinna, 2004; Stewart & Mitchell, 2003), with very few HRFK instructional methods available for teachers. Consequently, the KIA fitness lesson segments were developed. It was discovered that: (a) 5th grade students in the KIA fitness lesson segments had significantly improved HRFK scores at posttest, and (b) students from the intervention group maintained physical activity levels as compared with the comparison group students.

According to Doyle (1977), students should be fully immersed and actively engaged in the curriculum to have the greatest positive effect on learning. The KIA fitness lesson segments were designed with this in mind. The KIA fitness lessons provide HRFK concepts from each of the eight performance descriptors on the PE Metrics cognitive test. For example, the HRFK concept, specificity and identifying ways for students to get active outside of school, was incorporated in the 'Roll the Dice' activity. This station was designed to challenge students to correctly select exercises that are associated with a particular health related fitness component and perform that exercise the number of times indicated on the dice. This concept is housed in the performance descriptor, 'Describes characteristics of health-enhancing physical activity', which showed a considerable increase at posttest. According to Chen (2001), challenging students in the classroom has been shown to increase student motivation and engagement, which can aid in learning. This mediating factor was identified as one reason for the positive results from the KIA fitness lesson segments. Another HRFK concept taught in the KIA lessons was identifying moderate to vigorous activities, and the effects these activities have on the body. This concept is actively taught in the KIA lesson segment called, Take

your Heart Rate, and found in PE Metrics performance descriptors, “describes personal responses to physical activity” and “describes characteristics of health-enhancing physical activity”. Take your Heart Rate incorporates this concept and asked students to pick from either a moderate or vigorous aerobic activity and perform that exercise at their own pace. Once students performed this for the duration of the station, they were asked to check their heart rate and identify how the exercises affected their heart. Allowing students to work at their own pace, and select their own level of difficulty in tasks, has been seen to positively influence students’ competency levels (Byra & Jenkins, 1998). The effects were also positive as students scored high on these test items.

After all items were reviewed, researchers found one particular concept difficult for students to comprehend, weight-bearing activities. This concept is found on item 10 and 11 on the PE Metrics exam, and in the performance descriptor “describes characteristics of health-enhancing physical activity”. Although this concept is emphasized in the Bearing the Weight activity, students had extremely low scores at posttest. One possible explanation documented in field notes was participating teachers’ misinterpretation of the weight bearing concept. Field notes indicated that teachers were offering improper weight-bearing activities to the class during the checking for understanding transitional period. Researchers believe training of the tested concepts will increase the teachers’ comprehension possibly aiding student knowledge acquisition. This resonates with Shulman’s (1986) suggestion that sound content knowledge is one component necessary in achieving an influential level of instruction.

Physical Activity Maintained

Students in the intervention group accumulated more steps and time in MVPA than students in the comparison group. Although the HLM level-2 analysis did not yield significant differences, these results defend the use of KIA fitness lesson segments to not cause a decrease in student physical activity during implementation. This is a key finding as physical activity levels have been shown to be limited among many elementary students during their physical education classes and thus further time cannot be afforded (Fairclough & Stratton, 2005a; Fairclough & Stratton, 2005b; van Beurden, et al., 2003). Scruggs (2007) evaluated 5th grade students and the amount of steps they needed to accumulate to reach 50% of MVPA. It was found that approximately 82–87 steps per minute would be equivalent to reaching 50% of time engaged in MVPA (Scruggs, 2007). Based on descriptive results from the current study, students were engaged in approximately 72 steps per minute just missing the cut point. However, the intervention group students were on pace to reach 2,000 steps (estimated to be 2,160 steps for 30 minutes of class time), a recommended amount of steps for children during a 30-minute physical education lesson (Pangrazi, Beighle, & Sidman, 2002).

A few limitations to the study include the absence of an interrater reliability check as part of the fidelity of treatment assessment (although research team members were trained to evaluate fidelity). Another limitation is that findings may not be generalizable beyond the fitness focus portion of physical education lessons with a dedicated fitness focus. Within the framework of the DPE model, each lesson includes a specific section focused on physical fitness allowing equivalent assessments between KIA lesson groups and comparison teachers continuing to teach 4-part DPE model lessons. It is very important in physical education to teach enjoyable activities. Therefore, perception data are also needed and should be reported on the KIA lessons. Students’ perspective, and enjoyment as seen in Cognitive Mediation Theory, may play a critical role in facilitating student learning.

Conclusions

KIA fitness lesson segments provide teachers with one strategy that teaches HRFK during physical education class. This study demonstrated that fifth grade students could acquire HRFK while maintaining physical activity levels during the engagement of the KIA fitness segments. This strategy will aid in increasing the devastating low levels of HRFK among children and adolescents, which may play a role in students’ decision-making on engagement in leisure time physical activity. Individuals who are interested in the KIA materials may contact the principal author.

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