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FITNESS

Effect of Personalized System of Instruction on Health-Related Fitness Knowledge and Class Time Physical Activity

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Abstract

In previous studies, researchers have identified a general low level of health-related fitness (HRF) knowledge among secondary students that can effect levels of physical activity (PA). An instructional strategy that may increase HRF knowledge without decreasing PA is the personalized system of instruction (PSI). Two classes from a private urban high school in a major city within the Mountain West region of the United States participated in the 6-week study. Group 1 (n = 24) completed a unit on personal fitness using the PSI model, and Group 2 (n = 29) used a traditional DI approach. Knowledge was assessed 3 times (pre, post, 3-week follow-up) using a 45-question standardized HRF knowledge test. Class time PA was reported using a modification of the SOFIT observation system. A 2 × 3 ANOVA was used to compare HRF knowledge scores, showing a significant increase in Group 1 scores from pre- to posttest (p

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= 0.003) as well as significant increases in scores between Group 1 and Group 2 (p = 0.03). Physical activity results were compared using a pair-samples t test with outcomes revealing differences in class time PA levels (t = −0.27, p = 0.79). These results indicate PSI is a successful model for increasing HRF knowledge while maintaining physical activity levels.

According to the Centers for Disease Control and Prevention (CDC, 2011), participation in physical education (PE) is decreasing significantly during the secondary school years. Song, Carroll, and Fulton (2013) reported that only 16.3% of teenagers in the United States meet the CDC's recommended levels for physical activity (PA). As PA levels decrease, so do levels of health-related fitness (HRF; U.S. Department of Health and Human Services, 2010), which in turn leads to decreases in an individual's health (Eaton et al., 2012; Goldfield et al., 2011; National Center for Chronic Disease Prevention and Health Promotion, 2011). For adolescents, the natural venue for increasing PA and improving HRF is in PE classes (Moreno Murcia, Coll, & Ruiz Pérez, 2009; Pate, Ward, O'Neill, & Dowda, 2007; Sallis et al., 2012). This is good practice, but being physically active is only one goal of a quality PE program (American Alliance for Health, Physical Education, Recreation, and Dance [AAHPERD], 2013). By focusing solely on psychomotor outcomes, physical educators overlook the acquisition of the content knowledge related to health-related fitness (HRF), PA, and overall health.

Slingerland and Borghouts (2011) stated that PE can influence overall fitness levels of children and adolescents by engaging students in PA during class and instructing students to understand the benefits of PA outside of class. Yet traditionally there has been a lack of priority toward increasing the cognitive aspect of PE (Stewart & Mitchell, 2003), with several authors commenting on the lack of HRF knowledge and preparedness to engage in lifelong fitness in youth today (Brynteson & Adams, 1993; Dilorenzo, Stucky-Ropp, Vander Wal, & Gotham, 1998). As knowledge increases, adolescents possess a better understanding of a healthy life and what it takes to engage in PA (Keating, Harrison, Dauenhauer, Chen, & Guan, 2009). Ennis (2012) suggested these increases in knowledge can offset negative beliefs about fitness and combat the decline in PA within PE classes. Others have asserted that increased knowledge is more beneficial to lifelong fitness than increased in-class PA (Corbin & Lindsey, 2007). To assist students in becoming more ac-

tive during PE class, teachers need to be able and willing to provide quality instruction with appropriate instructional strategies (Bryan & Solmon, 2012) that address HRF knowledge and PA.

Eight common instructional models have been shown to be effective in teaching PE including direct instruction (DI) and the personalized system for instruction (PSI; Metzler, 2005). DI is a teacher-centered approach in which the instructor determines the majority of the content of the lesson and class and how much students are involved in participation (Méndez, Valero, & Casey, 2010). It has been suggested DI is an appropriate strategy to use when basic skill development and safety issues are of highest importance or when working with younger students in skill development (Ayers et al., 2004; Sweeting & Rink, 1999). The DI model requires the teacher to have a high level of expertise and to have control over the progression of the lesson including assessment, practice time, and tasks. As noted, this approach works well with skill development, yet has not proven to be as effective in developing HRF knowledge. Opponents of DI have stated that when a person uses this strategy, creativity and the ability to problem solve decrease (Peterson, 1979). If an outcome of a quality PE program is to have students be able to apply what they have learned in class (AAHPERD, 2013), they must be able to do more than restate concepts they have learned (Castelli & Williams, 2007).

Another instructional model is PSI. It was originally designed by Dr. Fred Keller in the early 1960s to replace traditional lecturing and incorporate an independent mastery learning approach to learning (Keller, 1968). The "Keller Plan," as PSI is sometimes referred to, has five distinct characteristics: self-pacing, mastery learning, emphasis on the written word for learning, teacher as motivator, and the use of proctors (Keller, 1968). Since the mid-1960s, PSI has been used throughout the educational domain with tremendous success (Bangert, Kulick, & Kulick, 1983; Calhoun, 1977; Fell, 1989; Grant & Spencer, 2003; Johnson & Croft, 1975; Kulick, Kulick, & Cohen, 1979; Springer & Pear, 2008) including in PE. Successful use of PSI in PE has been documented for volleyball, golf, racquetball, and tennis (Metzler & Sebolt, 1994) as well as personal fitness (Colquitt, Pritchard, & McCollum, 2011). Hannon, Holt, and Hatten (2008) used this instructional model to teach HRF content knowledge in a high school weight training class. Pritchard, Penix, Colquitt, and McCollum (2012) used PSI to teach a weight training class. Their results show students significantly increased their HRF knowledge and fitness levels (curl-ups, push-ups, and body composition). These

results indicate that PSI not only increases student content knowledge, but also provides the PA needed to increase fitness levels. PSI has been researched in few studies at the high school level, but this strategy shows potential to be an effective mode of instruction to improve student HRF content knowledge.

PSI is a unique approach to increasing HRF content knowledge. Researchers have suggested the use of PSI increases student learning and allows for more PA through increased practice time and decreased teacher management time (Cregger, 1994; Metzler, 1986). However, few researchers have examined the effectiveness of PSI during a high school personal fitness class. Therefore, the primary purpose of this study was to investigate changes in HRF knowledge between a personal fitness class in which the PSI strategy was used and a class in which the DI model control was used. We hypothesized students in the PSI class would have significantly higher HRF knowledge gains after a 6-week study than students in the DI class. The second purpose of this research was to explore differences in PA between the classes. There are arguments indicating that concentrating on HRF knowledge can decrease overall class-time PA, which can be counterproductive for a standards-based PE class. Therefore, we hypothesized there would be no significant difference in PA levels between the PSI class and the DI class, signifying the potential to teach HRF while maintaining appropriate PA levels.

Method

Participants

Two PE classes from a local private high school in the urban area of a large city in the Mountain West region of the United States were recruited for this study. In one class (n = 24, M_{age}= 15.4 ± 1.23 years), a personal fitness unit was implemented using the PSI strategy, and in the second class (n = 29, M_{age}=15.31 ± 1.17 years), a traditional DI approach was used to teach personal fitness. Approval from the school and university institutional review board was obtained and parental permission and child assent were granted prior to the beginning of the study.

Scheduling of the school allowed classes to meet in the school's weight room 4 days a week for 40 min. Available resources included a moderately sized fitness facility consisting of free weights, dumbbells, weight machines, and cardiovascular equipment. The classroom teacher (16 years of experience) was familiar with both instructional strategies. The principal investigator (PI) provided ad-

ditional training for the teacher in PSI philosophy and implementation.

Instrumentation

HRF content knowledge. Because of a lack of a standardized HRF knowledge assessment, a modified 45-question assessment pertaining to weight training and fitness was used to measure students' personal fitness content knowledge. The original assessment (Pritchard et al., 2012) had 50 questions initially, but five were dropped because of repetition and lack of relevance. Based on McGee and Farrow's (1987) test bank for PE activities, the assessment includes case studies and multiple-choice and true/false questions pertaining to cardiorespiratory endurance, muscle strength and endurance, flexibility, body composition, and nutrition. Students were awarded 1 point for each question, allowing them to score between 0 and 45 points. Assessment examples included the following:

- What is a function of fat?
- Which activity is the best example of aerobic exercise?
- Which is not a factor influencing flexibility?
- Which is the best example of measuring intensity for cardiorespiratory training?

The assessment and curriculum were evaluated by a certified strength and conditioning specialist from the National Strength and Conditioning Association as well as a high school PE teacher with over 12 years of teaching weight training classes to establish content validity.

Physical activity. Both classes were observed for levels of PA using a modification of the System for Observing Fitness Instructional Time (SOFIT; McKenzie, Sallis, & Nader, 1991) during class time to assess overall PA levels as well as time spent in moderate- to vigorous-intensity (MVI) activity. In this systematic observation, a 5-point scale is used to measure student PA: 1 = *lying down*, 2 = *sitting*, 3 = *standing*, 4 = *walking*, and 5 = *vigorous* (activity requiring more effort than walking). In SOFIT, a time interval of 10 s observation followed by 10 s of recording is used. Five students were observed based upon McKenzie's (2012) protocol of entering the room. The first participant was observed for 12 intervals (4 min) before moving to the second, then the third, and so forth. Students were observed for the entire class period (~32 min). Twelve class periods (six for each group) were observed during the 6-week study.

As no observation tools have been used for resistance training, modifications were made to the original SOFIT scale. The first two scores were kept and "spotting" was grouped with the third. For the remaining two levels, Ainsworth et al.'s (1993) compendium was consulted with MET values for walking (3.0) compared to values for light to moderate resistance training (3.0). Examples include bicep curls, abdominal exercises, and body weight activities. Vigorous effort was classified as activity requiring more effort than light to moderate effort (> 3.0 METS). Interrater reliability protocol established by McKenzie (2012) was followed with a result of 86.3%, exceeding the preestablished mark of 80% reliability.

Protocol

One week prior to the start of the study, students in both groups completed the fitness concepts assessment to establish baseline knowledge. Participants were instructed to answer the questions to the best of their ability. Upon completion of the 6-week study, participants completed the assessment to determine potential changes in knowledge. Students again completed the knowledge assessment 3 weeks poststudy to examine retention of learning.

PSI class. During the 6-week study, Group 1 followed a curriculum adapted from Colquitt, Pritchard, and McCollum (2011) for personal fitness in which the PSI model was used. The curriculum consists of 16 modules designed to teach HRF and introductory resistance training. A characteristic of PSI is the students' ability to progress through the curriculum at their own pace, and they are allowed to choose which content or exercise skill modules they want to work on. Periodic reviews of the classes were conducted to provide necessary feedback to the classroom teacher to ensure fidelity of PSI (Tables 1 and 2). These reviews consisted of observation of student and teacher activity and student workbooks. If benchmarks were not being met, the PI would notify the classroom teacher and suggest strategies to meet standards.

Table 1
Teacher Fidelity Benchmarks for Personalized System of Instruction

Benchmarks	How to verify
Teacher ensures PSI course materials are clear to students	Monitor the number and types of questions students ask after reading/viewing information in their workbooks.
Teacher has very low percentage of managerial time in class (< 2%)	Use a stopwatch to measure how much management time teacher uses in class.
Teacher has very high rates of individualized instructional interactions in class	Audiotape a lesson and count the number of cues, number of times feedback is given, and the number of questions directed to individual students.
Teacher sets performance criteria for tasks at appropriate levels of difficulty	Direct students to practice tasks in blocks (e.g., 10 trials) and to record the number of successful tasks in each block. If most students reach mastery after one or two blocks, the task is too easy. If many students get "stuck" on a task, it is too difficult. Adjust the task or performance criteria accordingly.
Teacher does not spend too much time witnessing and verifying mastery attempts	Count the number of times the teacher witnessed mastery attempts in each class. If that takes away from instruction time, (1) design more self- and partner-checked tasks or (2) appoint dependable students as temporary witnesses until the backlog is gone.
Teacher makes few or no task presentations	Count the number of task presentations made in class. If those presentations take away from instructional time with individual students, design and produce media-based task presentations.

Table 2
Student Fidelity Benchmarks for Personalized System of Instruction

Benchmarks	How to Verify
Students have understood written or visual task presentation	Check for understanding. Monitor students on comprehension tasks that demonstrate key elements from the task presentation. Note the number and pattern of students' questions.
Students are staying on task	Periodically monitor and count the number of students who are on task in class.
Students can properly set up learning activities from the written task structure information	Observe several students setting up learning stations. Note how long it takes each one to set up and how correctly it is done.
Students do not make "inappropriate progress" (i.e., cheat on verifying mastery)	Review students' progress chart each day, looking for faster than expected progression.
Student progression is more or less even	Review personal progress charts often.

DI class. For the DI group, class content matched that used with the PSI group. The classroom teacher determined progression, evaluation, and time spent on each topic. Instruction, including demonstrations of lift techniques, was given to the class as a whole. Daily workouts were written on the board and explained to the students. The class was divided into three groups to prevent backlogs on equipment.

The following knowledge and skills were covered in both classes: fitness assessment; cardiovascular; resistance and flexibility training; fitness principles; program design; nutrition and fluid balance; and lifts for chest, legs, back, arms, and abdominals.

Data Analysis

We used a quasi-experimental, nonequivalent design (Campbell & Stanely, 1963) because we used preestablished classes. Data were

analyzed using SPSS 20 (SPSS, Inc., Chicago, IL) and checked for missing values, outliers, and normality. Missing data were excluded pairwise during analysis. Statistical significance was set at the 0.05 level for analyses. Scores from HRF were analyzed via a 2 (Group) × 3 (Time) analysis of variance (ANOVA), and class PA differences were analyzed with *t* tests. Means and standard deviations of descriptive statistics are included in Table 3.

Table 3
Descriptive Statistics

Dependent variable	PSI (n = 24) $M \pm SD$	Control (n = 29) $M \pm SD$
Age (years)	15.40 ± 1.23	15.31 ± 1.14
Pretest Scores	13.72 ± 3.89	12.90 ± 5.23
Posttest Scores	17.60 ± 6.59	14.14 ± 4.68
% Time Spent in MVI	21	20.3

Note. MVI = moderate to vigorous intensity.

Results

HRF Content Knowledge

Pretest scores from the HRF were analyzed to determine significant differences prior to the beginning of the study (Campbell & Stanley, 1963). No significant differences were observed between groups at pretest, $F(1, 52) = 0.420$, $p = 0.52$. Test scores significantly increased, $F(1, 24) = 6.78$, $p = 0.003$, in the PSI group from pretest ($M = 13.72$, $SD = 3.89$) to posttest ($M = 17.6$, $SD = 6.59$). Significant differences in posttest HRF knowledge scores, $F(1, 52) = 5.05$, $p = 0.03$, were also observed between the PSI group ($M = 17.6$, $SD = 6.59$) and the control group ($M = 14.14$, $SD = 4.68$).

Physical Activity Levels

Results from the modified SOFIT observation tool were analyzed to investigate if there were significant differences between the two groups in time spent in MVI. A paired samples *t* test showed no significant differences ($t = -0.27$, $p = 0.79$) between the PSI group

(21% of time spent in MVI) and the control group (20.3% of time spent in MVI) during the 6-week study.

Discussion

It has been reported that PA decreases during the later adolescent years and students generally lack basic HRF knowledge (Placek et al., 2001; Stewart & Mitchell, 2003). Researchers have stressed the importance of HRF knowledge in maintaining PA and healthy lifestyles throughout adulthood (Corbin & Lindsey, 2007; Ennis, 2012; Keating, Harrison, Dauenhauer, Chen, & Guan, 2009; Slingerland & Borghouts, 2011). To overcome this trend, PE practitioners need to address the content of what they are teaching and the strategies they are incorporating to teach it. Successful incorporation of content knowledge and skills has been demonstrated to improve HRF knowledge and retention (Adams, Graves, & Adams, 2006). An effective model to develop skills in PE (Cregger, 1994; Cregger & Metzler, 1992; Colquitt et al., 2011; Pritchard, Peniz, Colquitt, & McCollum, 2012), PSI is an instructional strategy that can be implemented to teach HRF in secondary education (Hannon, Holt, & Hatten, 2008; Pritchard et al., 2012). Unfortunately, there is little research on PSI used to teach personal fitness in the high school setting. Therefore, the purpose of this study was to examine changes in HRF content knowledge and PA between a class in which PSI is used and a class in which DI is used.

Participants within the PSI class demonstrated significant increases in HRF content knowledge compared to their counterparts in the control class over the course of the study (Figure 1). The results show a significant increase in HRF knowledge in the PSI class compared to the DI class, but overall scores reveal both classes did not elicit passing grades (PSI = 37.7%, DI = 31.1%), even with the curriculum designed specifically for personal fitness and HRF knowledge. Previous research supports the results from this study, suggesting that many students lack HRF knowledge initially (Brusseau, Kulinna, & Cothran, 2011; Kulinna, 2004; Placek et al., 2001; Stewart & Mitchell, 2003; Thompson & Hannon, 2012). More effort needs to be made to provide opportunities for HRF content learning at all age levels.

Little research has been conducted in which researchers have examined how concentrating on HRF knowledge affects PA levels (Thompson & Hannon, 2012). A secondary purpose to this study was to examine potential differences between classwide activity

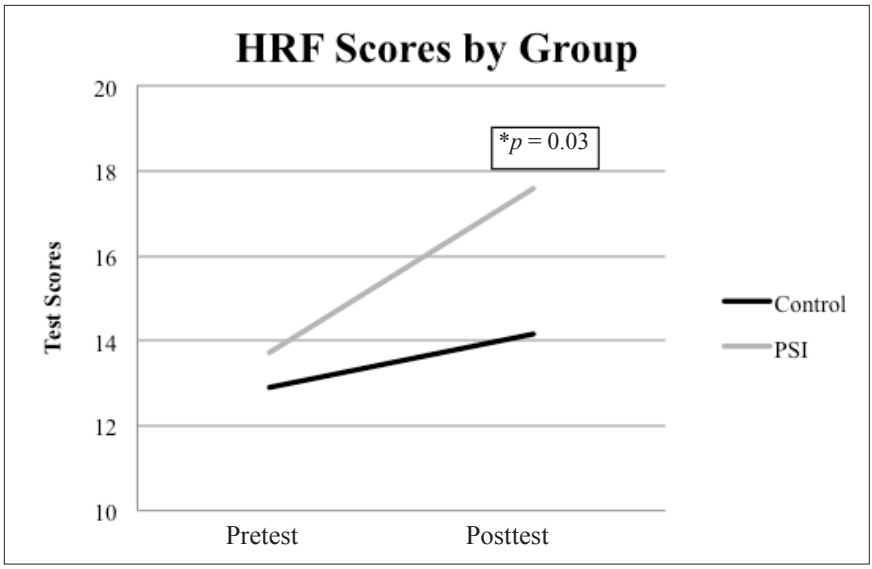

Figure 1. HRF test scores over time.

levels in a traditional DI approach and activity levels in a class in which the PSI strategy is used. This study shows no significant differences in class time PA between the two groups, indicating that through the use of PSI, students can increase their knowledge while maintaining current activity levels. Though this is one outcome, more research needs to be conducted to investigate potential relationships between knowledge and PA levels. With the national push to increase school-aged students' PA (Let's Move! Active Schools, 2014; National Board for Professional Teaching Standards, 2014), showing students how to be active is not enough. Educators and researchers need to be able to show students why and how to be physically active.

Two characteristics of PSI make it a unique strategy in education. The first is mastery learning. Students were required to complete assessments as they progressed through the modules. Each module required students to score 80% or higher on its quiz and to achieve 100% on individual assignments. If they did not reach these benchmarks, they were permitted to retake the quiz or recomplete the task until they demonstrated mastery of the subject. This emphasis on mastering the skills and content has been shown to improve feelings toward the topic and increase retention of the knowledge

learned (Guskey & Gates, 1986; Kulik, Kulik, & Bangert-Drowns, 1990).

The second unique characteristic of PSI is self-pacing. Metzler (2005) stated that when using the PSI model, students can progress "as fast as they want, or as slow as they need" (p. 221). Students who have experience or a background in the content are able to move at a quicker rate than those who are unfamiliar and need more time to learn and practice. This approach, along with increased practice times, couples with mastery learning to ensure students are confident and able to perform skills or retain content knowledge. In the traditional DI approach, the teacher determines the pacing of the course, thereby not allowing all students the opportunity to learn fully. With an increase in perceived competence through increased practice and feedback, students are more inclined to engage and participate in PE classes.

Although the results from this study are positive, generalizations should not be overtly made toward other curricula. PSI is effective for teaching skills in other activities, but we only examined HRF content knowledge compared to a non-PSI class. We suggest that more PSI research be conducted to examine differences between PSI and other models in all areas of PE.

This study had a few limitations. First, a relatively small sample size was used. This was a private school, and class sizes were generally under 28 students per class. A second limitation may be the lack of randomization. The classes recruited were used intact to maintain continuity for students' schedules. Finally, there were few females in this study ($n = 7$).

As mentioned previously, we only examined changes in knowledge within a smaller school. We encourage in future research not only the examination of the use of PSI in personal fitness classes at various sized schools, but also in a variety of PE content, such as individual sports. Another suggestion for research would be to examine the use of technology (computer-assisted instruction) incorporated into PSI teaching.

Conclusion

The results from this study indicate the PSI model could be an effective way to increase HRF knowledge with high school students while not decreasing their PA levels within the class time. This study lines up with the literature in which a lack of HRF knowledge is demonstrated, indicating more research needs to be done into methods to reverse this trend. With the decrease in PA and HRF within

the adolescent population, effective instructional strategies need to be incorporated into everyday PE. By providing teaching that concentrates on the how and why of being healthy, teachers give students the tools needed to lead long, healthy lives.

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