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TEACHING THE RESISTANCE TRAINING CLASS: A CIRCUIT TRAINING COURSE DESIGN FOR THE STRENGTH AND CONDITIONING COACH

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Strength and conditioning coaches in high schools and small colleges are asked to perform duties beyond working with athletes, including teaching resistance training courses. Many have not had teacher preparation. This article will address guidelines for physical activity and provide a course description and rationale for a circuit training program.

Key Words: circuit training, pedagogy

INTRODUCTION

Required physical activity is not as common as it once was in the United States. This is distressing because regular participation in physical activity helps students improve their healthy lifestyle skill repertoire, improve their health, find new activities that will appeal to them, aid in learning, enhance social development, and reduce behavior issues (5, 17). However, public schools and higher education have cut back instructors and core requirements in response to economic realities and pressure to improve performance in the academic subjects (17, 29). Another rationale for the decline in required physical education is that traditional physical education has not necessarily led to improved fitness or the acquisition of lifetime physical activity skills (12, 24, 37, 40).

It has been suggested that this reduction in required physical activity has contributed to the rise in adolescent and early adult weight gain and that reinstating required regular physical activity may help to combat this observed increase in average body weight (5, 29, 36). In response, the U.S. government implemented the Child Nutrition and WIC (Special Supplemental Nutrition Program for Women, Infants, and Children) Reauthorization Act of 2004 (Public Law 108-265) requiring that all school districts receiving federal monetary aid for school lunch programs combat childhood obesity by establishing a school wellness policy that includes (amongst others) physical activity, combating early obesity, and measurable outcomes (14). The Centers for Disease Control and Prevention (CDC) endorses adult-supervised strength-training for adolescents as a method to increase purposeful activity and reduce obesity (13). The American Academy of Pediatrics also recommends personal fitness activities and a combination of resistance and aerobic training to provide general health benefits and to aid in weight management (21, 38).

An American College of Sports Medicine (ACSM) survey of health and fitness professionals indicated that the number two Worldwide Fitness Trend for 2009 is addressing early onset obesity (32). To do this the CDC's 2008 Physical Activity Guidelines for Americans recommends that adolescents participate daily in at least one hour of moderate to vigorous-intensity aerobic physical activity (9). In addition, adolescents should do both vigorous-

intensity and muscle- and bone-strengthening activity on at least three days per week (9). The British Association of Exercise and Sport Sciences has also recommended that young people resistance train a minimum of two times per week to improve muscular strength, flexibility, and bone health (30). The ACSM recommends at least 30 min of aerobic activity on at least five days per week and strength training at least two days per week for young adults (33).

Circuit training is a time-efficient exercise routine offered in health and fitness centers throughout the country. Programs consisting of both weight and aerobic training can meet the recommended quantity and mode of exercise and controlled exercise studies have demonstrated enhanced health-related, cardiorespiratory, and muscular fitness (19, 20, 26). However, how to do this, and to encourage exercisers to maintain their own overload, progression, and motivation outside of a research study and within the classroom, remains a concern. Thus, a cost-effective and successful alternative to traditional physical education needs to be found and implemented.

One proposed alternative to formal physical education has been to use fitness activities that provide individuals with the skills and knowledge necessary to continue to exercise on their own in community programs (39). To do this, many high schools and small colleges are using strength and conditioning specialists to teach resistance training courses and to play a greater role in addressing youth and young adult health and fitness outcomes and to meet the requirements of Child Nutrition and WIC Reauthorization Act of 2004 (14). These specialists are being asked to go beyond working with athletic teams to supervising and teaching resistance training courses.

While supervising resistance training is within the scope of practice of strength and conditioning coaches, teaching competencies may be beyond what many are prepared for. Courses in teacher preparation are not usually a required component of most university strength and conditioning curricula and are not required by the NSCA Education Recognition Program (ERP) (28). Thus, some assistance in course design may prove beneficial for strength and conditioning coaches. What follows is a description of a suggested course design for a resistance training class that will provide strength and conditioning specialists with an instructional framework to follow if asked to teach a weight training fitness class for the general student population. Fitness assessment results from this class will be discussed briefly to demonstrate efficacy.

The described course consists of two sessions per week for 15 weeks. It is a self-paced progressive circuit training program that can lead to improvements in health-related physical fitness and consumerism. The intention of this program is to develop a setting where individuals are supervised, encouraged, and monitored, yet allowed to self-determine intensity levels and when to progressively increase their workload in a classroom setting. A circuit training course is recommended as activities can be included to address multiple components of health-related fitness – aerobic, flexibility, and strength. In addition, the flow of circuit training reduces the ability of students to remain at one station and work only on what they perceive as important or enjoyable, develop muscular imbalances, or to not work at all. Results will also be presented to demonstrate that the described course produces significant changes similar to those found in controlled research studies using circuit training.

COURSE DESCRIPTION AND RATIONALE:

The goals of this course are to 1) enable students to enhance their physical fitness, 2) to improve their ability to become lifetime exercisers, and 3) to be better consumers of health and fitness information and products (Figure 1). A circuit training format is used in conjunction with regular fitness testing, quizzes, readings, and journals.

Circuit Training Protocol

The circuit training program consists of 13 resistance machine stations and 12 aerobic stations (Table 1). The stations are numbered and students are allowed to select the starting exercise and then sequentially follow the numbers through all stations. Each class session consists of a five minute aerobic warm-up followed by an instructor-lead five minutes of generalized stretching, and then two circuits are completed. Initially students exercise for 30 seconds with one minute of recovery per station (1:2 work to rest ratio). At week five the work to rest ratio is changed to 1:1 with 45 seconds of exercise and 45 seconds of recovery per station. At week ten the ratio is again changed: one minute of exercise with 30 seconds of recovery per station (2:1 work to rest ratio). An automated electronic timer is used to ensure constant interval duration. Exercise is followed by a five minute aerobic cool-down and an instructor-lead five minutes of generalized stretching.

A safe and comfortable progression from inactivity to habitual activity will also benefit less fit and/or intimidated students. The progression from a 1:2 to a 2:1 work to rest ratio (initially 12 minutes of total aerobic exercise and 13 minutes of resistance training progressing to 24 minutes of total aerobic exercise and 26 minutes of resistance training at the conclusion) allows students to get used to the routine and physical demands before asking them to work longer. In addition, multi-joint, large muscle mass movements are preferred to provide more functional training and muscle balance. This combination of intervals and large muscle mass involvement also increases the metabolic cost (total caloric expenditure) of the exercise and results in a greater potential for weight loss (8).

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Student Assessment

Fitness Testing: A common aggravation with this type of activity class is dealing with sporadic attendance and participation. Exercise and attendance motivation can be improved with fitness tests (22). These tests demonstrate to students where they are in relation to others and norms, as well as providing guidance in which areas to improve. Repeated tests also enhance motivation by indicating progress and program effectiveness. The fitness tests selected for this program are representative of the various fitness components, are easy to administer in a group setting, and are appropriate for individuals of varying fitness and experience levels. The fitness tests include: body mass (BM), estimated maximal aerobic power ($\dot{V}O_{2\,max(est)}$) and heart rate recovery (HRrec) using the five minute Sharkey Forestry Step Test, low back and hamstring flexibility (FL) using the sit-and-reach test, and a calculated one repetition maximum (1RM) for the chest press (CP), leg press (LP), and latissimus dorsi pull-down (PD) (1, 2, 16). Fitness testing is most beneficial if conducted pre-participation (Pre) in the program, at the midpoint (Mid), and post-training (Post). No grades are assigned to these fitness tests.

Quizzes: Quizzes are given randomly to encourage attendance and ensure that students are learning and practicing proper technique. Two weeks of circuit training and instructor technique critiques occur before the first quiz and then students are told to expect a quiz approximately every other week for a total of six quizzes across the semester. These six quizzes total 25% of the student's grade (Table 2). Each quiz is worth ten points and students can earn back half of the missed points by doing corrections prior to their next quiz. Unexcused missed quizzes are made up in this half-credit fashion as well.

The quiz format can be found in Figure 2. As students rotate through the selected station, they identify the prime movers and the muscles providing major assistance. Students then verbally explain seat/machine adjustments and safety considerations while demonstrating that they can appropriately make these adjustments. Technique is then observed as the movement is executed. A correct answer/movement receives a 1, incorrect a 0. No partial credit is given and comments are provided to help the student with corrections and to improve later performances.

Literature Reviews: In an effort to address consumer education, students complete literature reviews (Figure 3) every other week for a total of six reviews across the semester. Each review is worth ten points and these six reviews total 25% of the student's grade (Table 2). The reviews are formative assignments and grades are essentially awarded for completion. Students are required to read self-selected exercise-related articles from the popular media and prepare a written summary. The summary is turned in to the instructor and students are randomly selected to engage in a dialogue about their findings with the instructor. These discussions take place while the class participants are warming-up, exercising, and cooling down. During the discussion, students provide their input and beliefs about the effectiveness of the author's suggestions and the instructor provides commentary regarding the science behind each concept. Students are occasionally encouraged to read follow-up articles from peer reviewed research to enhance understanding.

Journal: Students also keep a daily training journal of the weight used, the number of repetitions completed, periodic heart rates, and rating of perceived exertion (RPE). This journal, along with a self-reflection regarding personal fitness, is turned in for instructor review at the end of each week. Each week is worth ten points and the journal totals 25% of the student's grade (Table 2). These too are formative assignments and grades are essentially awarded for completion. Journaling not only keeps the students accountable to themselves, but allows the instructor to carry out a private, fitness-related conversation with students to acknowledge their individual trials and tribulations.

Demonstrated Awareness: The remaining 25% of the student's grade is assigned based on demonstrated awareness (Table 2). This is subjectively based on the instructor's assessment of the student's contribution to a positive classroom environment, demonstrating a basic comprehension of the muscular and skeletal anatomy, and routinely providing consistent effort and proper execution of movements. This is essentially the participation grade that many expect to be a component of activity classes.

Attendance: Attendance is not mandatory in this model and does not directly play a role in student grading; although, it can influence the demonstrated awareness portion of the grade. Attendance is encouraged by the randomly selecting students to take the oral prime mover quiz and/or to initiate the fitness topic discussions each day. If students are not present when their names are randomly drawn, they are allowed to take the quiz or present their literature review during the next scheduled class; however, their quiz grade is reduced by 50% and the literature review by 10%.

Steps were taken to enhance student motivation and encourage active participation and appropriate exercise intensity. The mean attendance of 27 ± 2 of 30 class sessions (range of 22 – 29) indicates that the strategies utilized were effective and this is a key outcome of this course design. Encouraging student attendance by randomly scheduling assessments promoted student turnout. Registering for graded school credits not only enhanced

motivation, but also provided a scheduled place and time for exercise and this has been shown previously to enhance motivation and adherence (15). Monitoring and maintaining an appropriate exercise intensity using heart rate and RPE (modified BORG ten point scale), as was done in this study, also improves exercise adherence and maintenance of an appropriate exercise intensity (15). In addition, regularly scheduled journaling and reflection increases exercise adherence and encourages goal directed behavior (4). External acknowledgement of effort and success enhances motivation; thus, the instructor worked to increase motivation by actively participating in the daily classes by conducting oral quizzes, discussing the articles read in an open forum, responding to student journal entries, and providing positive feedback (3, 22). In addition, frequent fitness testing was used to increase student motivation by establishing an appropriate baseline level to work from, monitoring progress, providing concrete results, and presenting proof of success (22). The low level of attrition and high attendance indicate that this combination of motivational enhancers can be effective.

Course Sequence

The first class meeting is an orientation to the weight room (Figure 4). A handout detailing the anatomy and prime movers of each movement is provided to the students and they are instructed as a group in proper exercise technique at each station. They are then allowed to explore the equipment while technique is randomly critiqued by the instructor. Fitness testing occurs during the second class. Circuit training actually starts with the third class period. Two weeks of guided practice and familiarization are allowed prior to quizzing and the instructor provides critiques to improve technique and maximize safety as students move through the circuit.

Participants are instructed to begin their strength training routine using 60% of their PRE 1RM (one second up, two seconds down cadence) and to increase the resistance when their RPE falls below a seven (very hard) for a movement (7). Participants are also encouraged to adjust resistance levels if appropriate after 1RM testing at the midpoint assessment. Participants are instructed to self-select the pace and to maintain an RPE of seven when using the aerobic stations.

EFFICACY

Of course, one must ask "does this course format improve fitness?" Measurable outcomes demonstrate program effectiveness and may be required (14, 41). Data collection and analysis are becoming increasingly important as consumers, administrators, and regulators expect significant changes demonstrating program success as they make difficult decisions regarding the allocation of limited resources (23). In addition, the fitness industry is moving toward greater accountability as this was identified as the number fifteen Worldwide Fitness Trend for 2009 (32). Fitness testing aids the strength and conditioning coach in demonstrating program efficacy.

Fitness test outcomes are presented here to indicate that improvements are similar to those found in formal, controlled research studies (18, 19, 26). The outcomes presented here are from a course consisting of an original enrollment of 23 students at a small southwestern university. Three students were not included as they were varsity athletes engaged in athletic conditioning outside of the class, four students did not complete the course for personal reasons; thus, a total of 16 students (70%) were included. These 16 students had mixed physical activity backgrounds and were not currently participating in any other regularly scheduled physical activity. Enrollment in the course and the sharing of results was voluntary in that this course was not required for graduation and students were asked to anonymously volunteer their results after the course was completed and grades were determined.

Outcomes included were course attendance, $\dot{V}O_{2\,max(est)}$, HRrec, FL, and 1RM for CP, LP, and PD. Body composition was not measured as the most reliable methods (skinfolds or hydrostatic weighing) are not tools that lend themselves to use in large groups when a single individual must simultaneously supervise all participants. If the instructor wishes to measure body composition, bioelectric impedance (BIA) allows for quick estimates in large groups; however these results should be viewed with caution as BIA is dependent on individual hydration status and may be inaccurate for those who are particularly lean or have recently exercised or eaten (6). Measures of consumer knowledge and life-long physical activity were not made; however, journal entries and an interview during the course and in the year following addressed this.

Mean attendance was 27 (± 2) of 30 class sessions, with a range of 22 – 29 class sessions and all fitness test scores significantly improved from Pre to Post (Table 3). Journal entries and a survey of the students indicated that they felt more confident in their ability to independently use a fitness facility, to identify sound exercise programs, and to recognize unreasonable claims.

Students have not been followed extensively beyond one year after completion of the course, but those who have kept in contact with the author, indicate that they are more physically active than they were prior to taking the circuit training course. A few also indicate that this course served as the impetus for them to start competing in amateur sporting events such as road races and body building.

While the results of this study indicate that physical fitness can be improved and body weight decreased by participating in a self-paced circuit training class, the other potential academic and social benefits of such participation were not assessed. It is reasonable to expect that these benefits would accrue as well as others have demonstrated this to be the case (10, 11, 25, 31, 34, 35).

CONCLUSION

The enclosed course design is effective as a school-based, self-paced, fitness center-type setting at the small college level. Participation in a 15 week, two sessions per week self-paced circuit training course significantly improved FL, $\dot{V}O_{2\ max(est)}$, HRrec, and CP, LP, and PD strength while leading to a loss in body mass and the magnitude of these changes are consistent with those observed in other studies (19, 20, 26). Therefore, the inclusion of circuit training in a supervised, fitness center-type environment meets the objectives of improving measures of health related physical fitness and reducing student body weight. Furthermore, improvements in fitness can occur within the time limits of an academic semester and block class scheduling and does not require an inordinate out-of-class commitment from the instructor.

Beyond the goal of enhancing physical fitness, physical education should help individuals develop the skills and habits to become independent exercisers (13, 27). The growing trend of using personal trainers (the ACSM number three Worldwide Fitness Trend for 2009 is personal training for adults, children, and groups) indicates that individuals seek out professionals to help them make physical activity choices as they have not previously developed independent skills and habits (32). However, a self-paced circuit training program, as described here, promotes the knowledge and skills for independent exercise. Participants learn proper machine use, exercise technique, and weight room etiquette. They also learn how to assess their own performance and when and how to appropriately progress exercise intensity. Comfort in the weight room is improved as well. For example, participants reported being intimidated by the leg press when initially using it. This intimidation decreased as familiarity increased and the participants reported a greater willingness to work harder and explore their physical limits, resulting in a greater conditioning effect and progress toward the stated goal.

Aerobic power, flexibility, and strength improve while body mass decreases as a result of a twice a week circuit training class utilizing both resistance machines and aerobic intervals in a classroom setting. This is a working model that can be adopted by strength and conditioning professionals as they are asked to supervise weight room activity courses and play their role in combating the increasing number of overweight young people.

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Tables and Figures.

Table 1. Circuit training stations

	Aerobic Stations		Resistance Stations
1	Bicycle ergometer	2	Shoulder press
3	Jog pad	4	Leg press
5	Bicycle ergometer	6	Chest press
7	Jog pad	8	Thigh adduction
9	Bicycle ergometer	10	Seated row
11	Jog pad	12	Prone leg curl
13	Bicycle ergometer	14	Pec deck flies
15	Jog pad	16	Abdominal crunches
17	Bicycle ergometer	18	Pull-down
19	Jog pad	20	Upright row
21	Bicycle ergometer	22	Leg extension
23	Jog pad	24	Triceps extension
		25	Back extension

Table 2. Circuit training grading system.

Student Assessment	% of Course Grade
Quizzes	25%
Reviews	25%
Journal	25%
Demonstrated Awareness	25%

Table 3. Changes in the measures of health-related fitness and percent (%) change ($\bar{x} \pm s$) over 15 wk of circuit training.

Measure	Pre	Mid	Post	% Change
Flexibility (cm)	44.2 ± 6.6	48.4 ± 7.5*	50.0 ± 6.7*	9.0 ± 16.3
Heart Rate recovery (bpm)	118.1 ± 26.3	114.8 ± 23.5	103.9 ± 23.1*†	-11.0 ± 13.5
$\dot{V}O_{2\,max(est)}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	49.3 ± 11.4	48.9 ± 10.1	54.7 ± 9.8*†	12.9 ± 15.4
Chest Press (N)	357.3 ± 175.7	454.6 ± 205.0*	444.3 ± 170.5*	22.6 ± 22.8
Leg Press (N)	1140.7 ± 421.7	1502.7 ± 548.0*	1767.4 ± 749.3*†	60.0 ± 34.9
Lat Pull (N)	395.2 ± 145.2	505.8 ± 159.2*	530.3 ± 169.2*	30.3 ± 23.1
Body Mass (kg)	77.0 ± 22.3		74.7 ± 22.3*	-3.2 ± 3.5

Pre – pre-participation
Mid – midpoint
Post – post-training

*Indicates significant ($p \leq 0.05$) difference from Pre.
†Indicates significant ($p \leq 0.05$) difference from Mid.

Figure 1. Course Objectives:

Course Goal: Students will improve physical fitness, improve their ability to become lifetime exercisers, and be better consumers of health and fitness information and products.

Course Outcomes, Activities, and Assessment:

Upon completion of this course the student wi1l:

1. Demonstrate a variety of warm-up and flexibility exercises and perform these as a group before beginning each day's exercise session.
2. Demonstrate proper weight lifting techniques to be used on the weight training machines provided in class.
3. Improve aerobic fitness and muscular strength.
4. Be able to assess heart rate and calculate target heart rate range.
5. Demonstrate an understanding of the primary muscles used in different exercises (aerobic, weight training, and flexibility exercise).
6. Understand the components of total wellness and circuit training as a lifetime fitness activity and their relation to each other.
7. Demonstrate a variety of cool-down exercises (including flexibility) and perform these at the end of each exercise session.

Activities: lecture, demonstration, discussion, readings, and participation.
Assessment: quizzes, literature reviews, fitness testing, and participation.

Figure 2. Circuit Training quiz format.

CIRCUIT TRAINING
QUIZ

Score: _____/10

Name: _____ Date: _____

Station/Movement: _____

		1 or 0	Comments:
1.	Identify Prime Movers:	_____	
2.	Identify Major assistors:	_____	
3.	Seat/Machine adjustment & beginning body position:		
a.	Knowledge:	_____	
b.	Execution:	_____	
4.	Safety considerations:		
a.	Knowledge:	_____	
b.	Execution:	_____	
5.	Technique:		
a.	Movement path/alignment:	_____	
b.	Range of motion:	_____	
c.	Breathing:	_____	
d.	Speed of movement:	_____	
	Sum total:	_____	

Figure 3. Circuit Training literature review format.

CIRCUIT TRAINING
LITERATURE REVIEW

- May be of any topic pertaining to exercise or diet as they pertain to physical performance/appearance improvement.
- May be from any source.
- May be of any age.

Essentially you are writing to tell the reader four (4) things: 1) What are the claims made? 2) What must one do to achieve the stated outcomes? 3) Why the author believes this will work? 4) Do you believe this will work and why or why not? This is ***NOT*** to be a restatement of the article – you must read and summarize it.

Write-up Inclusions:

1. Your name, course number, assignment, and date.
2. Complete and correct reference for article.
   Author. Title. *Source.* Volume(Issue):pages, Year.
3. Summary
   Author's expertise
   Purpose
   Claims/Outcomes
   Summary of "method"
   Rationale provided by author
4. Evaluation
   Does this make sense to you? Why or why not?

Figure 4. Course sequence.

Day	Activity	Assessment
1	Orientation	
2	Fitness Testing	
3 – 10	Circuit Training (1:2 work-to-rest ratio)	Random Literature Reviews begin on day 5 (students can expect to present every other week)
11 – 14	Circuit Training (1:1 work-to-rest ratio)	
15	Fitness Testing	
16 – 20	Circuit Training (1:1 work-to-rest ratio)	Random Quizzes begin on day 7 (students can expect to be quizzed every other week)
21 – 29	Circuit Training (2:1 work-to-rest ratio)	
30	Fitness Testing	