The Impact of Music on Pacer Test Performance, Enjoyment and Workload
音樂對健身測試、愉快感及負荷量的影響

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Abstract

The purpose of this study was to establish what effect music has on students PACER test performance as well as their enjoyment of the test and perceived workload. Subjects were 72 boys and girls, age 9–11. Subjects completed the 20 meter multi-stage (progressive) cardiovascular fitness test known as the Progressive Aerobic Cardiovascular Endurance Run (PACER) on three consecutive regularly scheduled class periods. At the conclusion of each test, students filled out a Self-Rated Performance survey answering a number of questions about their perceived enjoyment as well as performance level. Each time the test was performed a different version was used, including a mild tempo, a higher tempo music as well as one with no music at all. Results indicated that the fewest participants regardless of gender attained their best score with the non-music version of the test [boys=8 (22%) and girls = 9 (28%]. The boys scored their highest scores on the mild tempo (n=17; 46%) while girls scored highest with the high tempo (n=13; 41%). When comparing test results to SRP scores, significant differences between each of the music versions compared to the non-music version existed (for no music versus mild, P=0.031; for no music versus faster, P=0.025). To conclude, students perform better cardiovascular when music is present. Boys perform better with milder tempo music while girls perform better on the higher tempo. Boys and girls also both enjoy the test more and perceive themselves to have worked harder when music is present as opposed when it is not.

Introduction

The Centers for Disease Control and Prevention (2009) reported that the prevalence of obesity among American children aged 6 to 11 has more than doubled in the past 20 years, and the rate among adolescents between the ages of 12 to 19 has more than tripled. Obese youth are more likely to have risk factors for cardiovascular disease (CVD), such as high cholesterol or high blood pressure (Hill & Wyatt 2005). Obesity is commonly referred to as a lifestyle disease and can be reduced with healthy lifestyle habits (Buchanan 2005).

Healthy lifestyle habits, including cardiovascular (aerobic and anaerobic) physical activity, can lower the risk of developing health-related diseases. In addition, physical activity is a vital component of today's youth health and fitness (Hill & Wyatt 2005). Adequate levels of aerobic capacity are associated with a variety of health benefits, including, but not limited to, a lower risk of heart disease, hypertension, and several types of cancer (Dietz, 2004). Due to its central importance to health, aerobic fitness is an important physical fitness indicator used in school physical education programs across the United States (Mahar, Welk, Rowe, Crotts, & McIver 2006).

Music has been commonly used to accompany and enhance exercise and physical activity in physical education programs (Crust & Clouch 2006). B. F. Skinner developed a theory that one's behavior is influenced by external factors, such as passive distracters (i.e. music) (Ward & Dunway 1995). Music has been used to enhance the psychological state of students to: establish an effective mindset, sustain motivation, and to resist mental and emotional fatigue (Mohammadzadeh, Tartibiyan, & Ahmadi 2008).

The possibility of using music as a passive distracter was investigated by Beckett (1990) by comparing walking distance travelled to recovery heart rates of 104 college students, under three different conditions (no music, continuous music, and intermittent music). The results indicated that music had a statistically significant effect on the recovery heart rates and that the intermittent music was slightly more effective at lowering recovery heart rates than the continuous. Another study conducted by Ward and Dunaway (1995) found that music was effective in raising the number of laps completed by high school students in a physical education class. An increase in the number of laps run from one to nearly three per minute represented a substantial increase in the exercise patterns of the students throughout the fitness unit. Conversely, Potteiger, Schroeder, and Geoff (2000) performed a graded exercise test on a cycle ergometer using 27 physically active adults. The exercise sessions of moderate activity used a variety of music and non-music variations. Unlike the previous studies (Beckett; Ward & Dunaway), no significant differences were found in test results between that of the music versions and the non-music version.

In addition, Gfeller (1988) investigated students' mental attitudes towards the use of music in relation to physical activity through survey research. The study found that 97% of the subjects reported improved mental attitudes toward the physical activity, while 79% indicated that music aided in their pacing, strength, and endurance. More specifically, Macone et al. (2006) examined the effects of music on mood, state of anxiety, and time to exhaustion during moderate-intensity exercise. The findings suggested that women, but not men, reported greater fatigue after exercising in the presence of music than in its absence.

Mohammadzadeh, Tartibiyan, and Ahmadi (2008) conducted a study and found that while exercising with no passive distracter (i.e. music) the subjects mostly concentrated on the negative effects of the workload (fatigue) and perceived their exertion rates to be higher than the numbers actually indicated. However, Potteiger, Schroeder, and Geoff (2000) found a significant positive difference between that of the music versions and the non-music version on a fifteen-point rating of perceived exertion survey completed throughout the testing on college students running on a treadmill. Therefore, research exists both to support and refute the effects of music on physical activity. The purpose of the study was to examine 4^{th} and 5^{th} grade students' scores and the impact of music, perceived enjoyment, and perceived work effort throughout the PACER (Progressive Aerobic Cardiovascular Endurance Run) test. The PACER test has three different variations: two are set to music and one is not. The PACER is a multi-stage (progressive) fitness test adapted from the standard 20 meter shuttle run test and is the recommended cardiovascular assessment for a variety of reasons. The test can be conducted indoors or outdoors, in areas with limited space, it can be run to music, and it may be more enjoyable than distance run tests for some participants (Meredith & Welk, 2005). To determine the subjects' attitudes and perceived exertion towards the PACER test variations a Self-Rated Performance (SRP) questionnaire was completed.

Methods

Subjects

The participants in the study included 72 students (9-11 years) from a Midwest United States elementary school chosen for its diversity in population. Of the 72 students, 69 (37 boys and 32 girls) returned the parental consent and child assent forms; therefore, 95% of the sample completed the study.

Procedures

Prior to completing the study, permission to perform research was attained from the Assistant Superintendent of Academics within the school district, from the parents/ guardians, and from the 4th and 5th grade (9-11 years old) students themselves. Upon receiving the signed consent and assent forms, all students completed the PACER test three separate times during the subjects' regularly-scheduled physical education classes. Immediately following each PACER test, the students also completed a SRP survey.

The students reported to the gymnasium at approximately the same time of day for each occasion. The testing sessions were separated by one day and were completed within a five-day school week. A counterbalanced random design was used to establish the order in which the children performed the three different PACER tests. During each class the students experienced one of three variations provided by the PACER CD: version 'A' with a high-tempo background music; version 'B' with a mild-tempo background music; and a version 'w/o' that included no music.

The elementary physical education teacher recorded each student's result on the PACER test and the research assistant (graduate student) collected the completed survey from each student immediately upon their completion of the PACER test. At this time, the physical education teacher also measured height (inches), weight (pounds), and age (years) of each student to establish an average age and BMI for descriptive statistics. The surveys and score sheets were immediately delivered to the principal investigator and data were entered into a spreadsheet for analysis.

Instrument

The PACER testing materials includes an administrative CD explaining the testing procedures to the participants accompanies. Regardless of which version is used, the test involves continuous running between two lines, in time, to recorded beeps. The workload (pace) increases at each stage until the children reached the maximal effort and could not continue. The test is progressive in intensity, starting out easier and getting more challenging (i.e. shorter time between recorded beeps); which, helps the student pace themselves and perform the test at a sustainable level. The progression helps avoid problems with inaccurate assessments commonly found with the one-mile run (McClain, Welk, Ihmels, & Schaben 2006; Mahar et al., 2006).

The test begins with a five-second countdown at which time a beep informed the students when to start running the first 20-meters. At the sound of the next beep, the students are instructed to turn around and run back to the original line which they began. If the students arrive at the line before the beep sounds, they are instructed to wait for the next beep before running the next distance.

The students continue the test until they fail to reach the line in the time allotted. The first time students do not reach the line by the time the beep occurs, the students are instructed to stop, reverse directions immediately, and attempt to get back on pace. The second time he or she fails to reach the line by the time the beep sounds (the two misses do not have to be consecutive), the test is completed for the student. In addition, a student who remains at one end of the testing area through two beeps (does not run to the other end and back) is scored as having two misses and his or her test is also completed.

Surveys: Students were instructed that immediately following each PACER test trial that they were to complete a SRP survey. The survey was designed to combine student feelings about the PACER test that they performed that day with the attained PACER test results. The answers were evaluated on a 4-point Likert scale in order to keep it manageable for the elementary participants. The surveys included four statements:

1. Rate your work effort (how hard you worked) today.
2. Did you enjoy the music played during the PACER today?
3. Did you feel the music motivated you to work harder during the PACER test today?
4. Rate your performance (how well you actually did).

Statistical Analysis

The results of each survey were combined and calculated to establish a SRP score for the respective PACER test performed. Body mass index (BMI) was also calculated for each participant in order to appropriately represent their height and weight [BMI = weight in pounds / (height in inches)^2 x 703)]. While other methods of body composition calculation may be more accurate, BMI is used in the public education schools. Descriptive statistics were calculated for all reported variables and separated by gender.

Pearson's correlation coefficients were calculated on the anthropometric variables (weight, height, and BMI), PACER scores, and SRP scores and analyzed by gender. Analysis of variance for PACER score was calculated and separated by gender and music version as fixed factors, with BMI used as a covariate. BMI was used as a covariate due to the fact that it is significantly correlated with PACER scores in both genders. Repeated measure analysis of variance was performed in the same manner for SRP scores as for PACER scores. During analysis another variable was created comparing each participant's best score and the version of the test that they performed it on. Finally, Chi-square analysis by gender was used to test for distribution of difference. The level of significance was set at $P \leq 0.05$.

Results

The results of the descriptive statistics calculated for all reported variables and separated by gender are shown in Tables 1 and 2. The means and standard deviations of the physical characteristics for boys were: age 9.84 years old (SD=0.60), height 56.36 inches (SD=3.04), and weight 96.68 pounds (SD=33.77); girls: age 9.81 years old (SD=0.74), height 55.51 inches (SD=2.82), and weight 85.59 pounds (SD=21.36). Mean values of the PACER and SRP scores can also be found for Tables 1 and 2 and in Figures 1 and 2.

Table 1. Descriptive Statistics of Reported Variables for Males.

	N	Minimum	Maximum	Mean	SD
Age (in years)	37	9	11	9.84	0.60
Height (in inches)	37	50	61	56.36	3.04
Weight (in pounds)	37	52	185	96.68	33.77
BMI (in MKS)	37	14.62	40.38	21.17	6.54
PACER (Non-music)	37	6	73	27.84	17.90
PACER (Music A)	37	6	73	29.19	19.34
PACER (Music B)	37	4	73	30.68	18.11
SRP (Non-music)	37	3	12	8.62	2.35
SRP (Music A)	37	4	12	8.92	2.14
SRP (Music B)	37	5	12	9.46	1.85

Table 2. Descriptive Statistics of Reported Variables for Females.

	N	Minimum	Maximum	Mean	SD
Age (in years)	32	9	12	9.81	0.74
Height (in inches)	32	50	61	55.51	2.82
Weight (in pounds)	32	53	136	85.59	21.36
BMI (in MKS)	32	14.05	27.70	19.26	3.35
PACER (Non-music)	32	7	46	20.56	10.87
PACER (Music A)	32	6	46	22.34	11.34
PACER (Music B)	32	7	50	20.75	11.17
SRP (Non-music)	32	4	12	8.63	2.21
SRP (Music A)	32	6	12	10.28	1.55
SRP (Music B)	32	5	12	9.72	1.89

Figure 1. The Mean Value of PACER Scores.

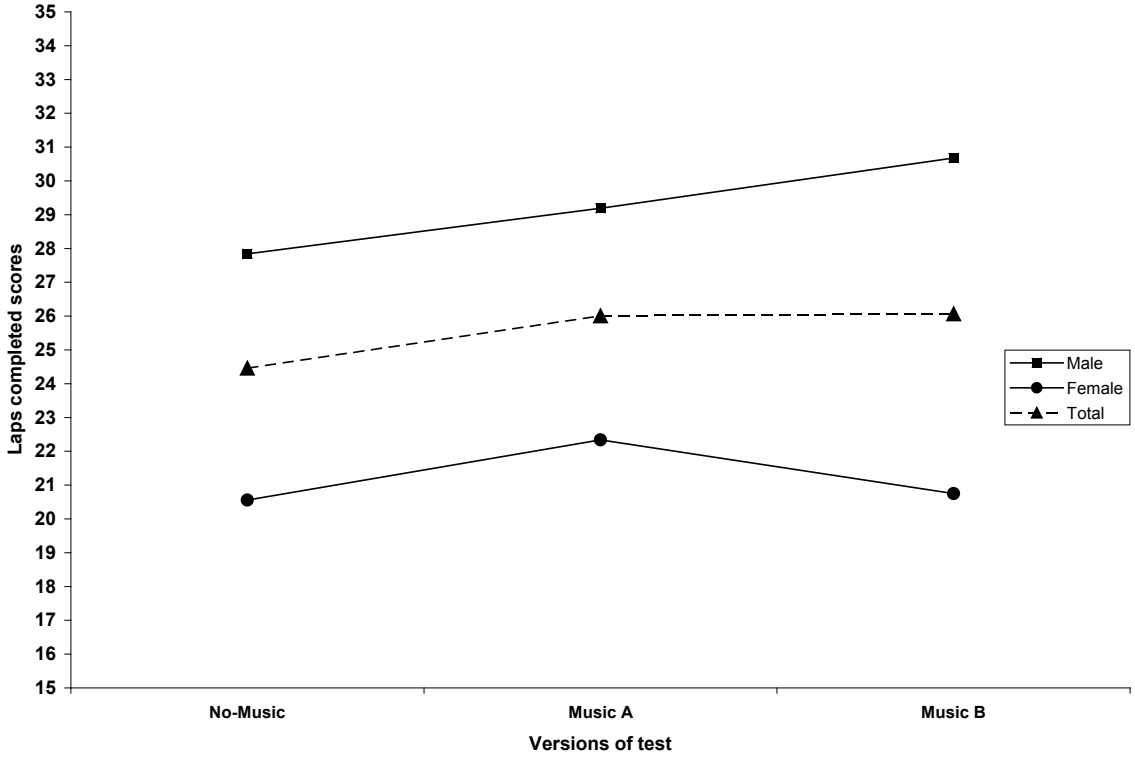
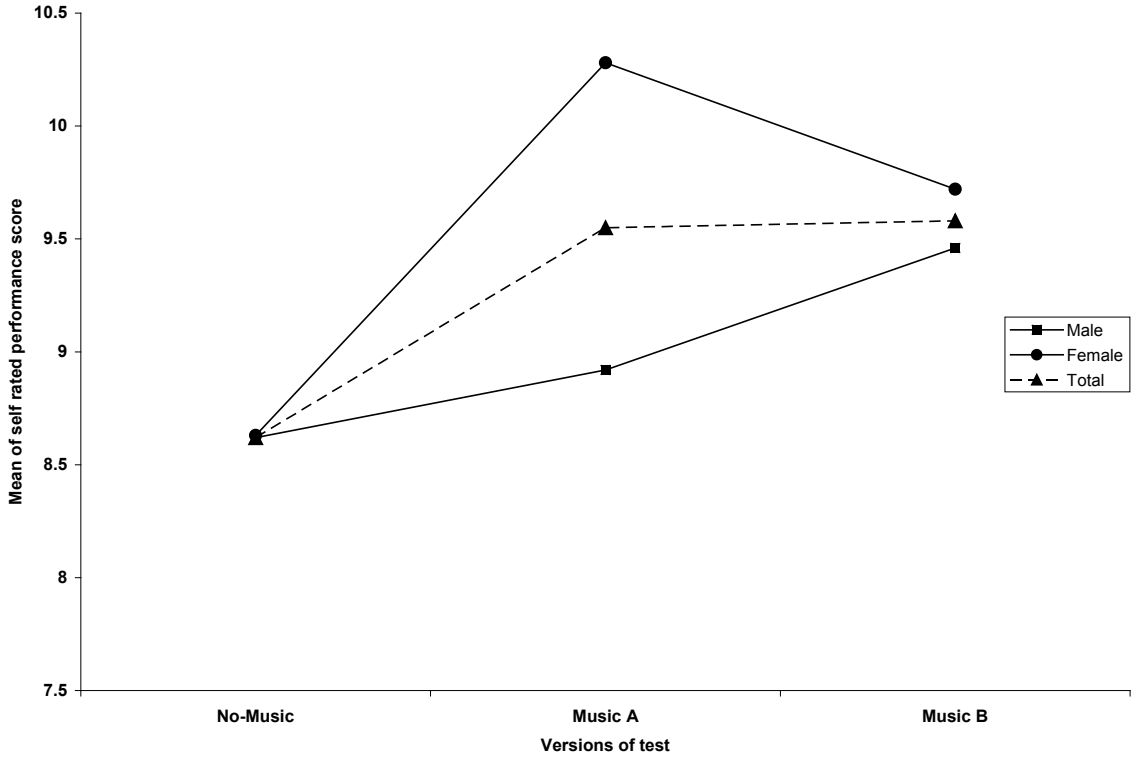


Figure 2. The Mean Value of SRP Scores.



The results of the Pearson's correlation (Tables 3 and 4) indicated a strong relationship between BMI and the students' PACER score in both boys and girls. The relationship showed that regardless of gender, BMI did affect the PACER test results; however, the direction of the association is not the same. For boys, higher BMI's were associated with lower PACER scores. In contrast, girls with higher BMI's were associated with higher PACER scores. Tables 3 and 4 show a strong relationship between the student's PACER test and SRP scores.

Table 3. Pearson's Correlations between the Anthropometric Variables, PACER and SRP Scores for Males.

	BMI	Height	Weight	PACER score	SRP score
BMI	-	0.232*	0.953**	-0.611**	-0.059
Height		-	0.501**	0.022	-0.194*
Weight			-	-0.539**	-0.113
PACER score				-	0.376**
SRP score					-

* Significant at 0.05 level

** Significant at 0.01 level

Table 4. Pearson's Correlations between the Anthropometric Variables, PACER and SRP Scores for Females.

	BMI	Height	Weight	PACER score	SRP score
BMI	-	0.682**	0.960**	0.539**	0.0004
Height		-	0.855**	-0.107	0.024
Weight			-	-0.415**	0.012
PACER score				-	0.271**
SRP score					-

** Significant at 0.01 level

Repeated ANOVA measures of the PACER score, controlling for BMI, showed significant effects for gender as seen in Table 5, with boys obtaining a significantly higher PACER score than girls.

Table 5. Analysis of Variance for PACER Score by Gender, Music Versions, and BMI.

Components of variation	df	Mean Square	F	P
BMI (covariate)	1	17132.674	109.842	<0.001
Gender (fixed factor)	1	6413.227	41.117	<0.001
Music versions (fixed factor)	2	54.273	0.348	0.707
Gender * Music version	2	47.752	0.306	0.737
Error	200	155.976		

Analysis of variance of the SRP scores did not show any significant effect of SRP score with BMI or gender, but results did show a significant effect for music version (Table 6). A Scheffe post-hoc comparisons showed significant differences between each of the music versions (mild and faster) and the non-music version of the test (for no music versus mild, P = 0.031; for no music versus faster, P = 0.025). However, no significant difference was found between the SRP scores and the two music variations ['A' and 'B'] (P = 0.997).

Table 6. Analysis of Variance for SRP Score by Gender, Music Versions, and BMI.

Components of variation	df	Mean Square	F	P
BMI (covariate)	1	1.424	0.347	0.557
Gender (fixed factor)	1	13.024	3.170	0.077
Music versions (fixed factor)	2	21.586	5.254	0.006
Gender * Music version	2	8.948	2.178	0.116
Error	200	4.108		

The highest PACER score for each student, regardless of the music version of the test, was considered as his/her 'best score'. Chi-square was used to examine the distribution of 'best scores' among the three test variations. The results showed that the fewest participants, regardless of gender, attained his/her best scores with the non-music version of the test [boys =8 (22%) and girls =9 (28%)]. The highest number of boys attained their 'best scores' with the music version 'B' (n = 17; 46%), while the highest number of the girls attained their 'best scores' with the music version 'A' (n = 13; 41%). While differences did exist including both boys and girls performing better on the PACER test with music playing, none were deemed statistically significant ($p < .05$; $\chi^2_{df=2} = 0.173$ for boys and $\chi^2_{df=2} = 0.698$ for girls).

Discussions

Similar to Beckett (1990) and Anil, Ashutosch, & Vivek's (2004) findings, the results of Mohammadzadeh, Tartibiyan, & Ahmadi's (2008) indicated that when the PACER test is performed with music, though not statistically significant, meaningful effect was found as the scores increased in both boys and girls. The same indications can be found from the results of this study.

As the results indicated, while not statistically significant, that students in general scored higher on the PACER test as well as had higher SRP scores when one of two music versions were present. A gender difference can be noted, with males being more likely to perform their best (see Figure 1) with music version 'B' (mild-tempo), while girls performed their best with music version 'A" (faster-tempo). Explanations for this might include the possibility that male subjects peaked early during the test using music version 'A' due to the faster-tempo music over-stimulating them. This overstimulation could be related to Brown's (1961) theory in which he believes that noise may affect an increase in muscular energy expenditure through significant increases in energy output and fatigue. Due to this significant increase in energy output and fatigue, males may perform better using the more mild-tempo version ('B') of the PACER test CD, helping to delay the onset of the peak and fatigue. Copeland and Franks' (1991) findings supported the use of mild-tempo music as soft, slow music was associated with an increase in endurance performance during an incremental exercise protocol.

The cardiovascular endurance of the participants was found to be significantly associated with their BMI; however, the association was negative with males and positive with females. The PACER score was also found to be significantly associated to SRP scores in both genders. Similar to the findings of Gfeller (1988) and Potteiger, Schroeder, and Geoff (2000), the significant association showed that the students perceived how well they performed accurately and that their enjoyment, or lack thereof, had a direct association with their performance.

The results of the analysis of variance revealed that variation in the PACER score was explained by the gender and BMI of the participants, while the variation in the SRP score was only explained by the different CD variations of the test. Therefore, this study suggests that although the PACER score is more likely to be affected

by the physical characteristics of the participants and not by the music, their SRP score is significantly affected by the music. In other words, the music is effective at enhancing their attitude towards performance but not their actual physical PACER test performance at a statistically significant level. If they enjoy the activity due to the use of music, this may increase the amount of time they spend practicing sports or simply participating in exercise. Either way, an increase in exercise time could eventually translate into a better PACER score. So, while the music itself may not have directly influenced the PACER score, it may in directly effect it by students spending more time training for the test due to their enjoyment (SRP score) of exercise while using music.

Suggestions for Teachers

Based on the results of this study, it is highly recommended that physical education teachers of adolescents offer a minimum of two PACER test trials during a fitness testing series. While some students did perform their best on the 'w/o' variations, the majority of the students (both male and female) performed their best on one of the two music variations ('A' and/or 'B') (Figure 1); therefore, to help both genders perform to their full capacity, each fitness testing series should include version 'A' (faster-tempo) and 'B" (mild-tempo) from the PACER test CD. The 'B' version (mild-tempo) of the test provides the students with a motivational beat, without over-stimulating them and causing students to peak too early in their test (Copeland & Franks, 1991). The 'A' version (faster-tempo) provides extra motivation for some students to help them achieve the best score they possibly can. Szabo, Small, & Leigh (1999) found that their results yielded a significantly higher exercise intensity and better efficiency in the slow and fast music, as opposed to no music being used at all.

The results indicated that, for most elementary school students, enjoyment of the PACER test was greater when it was performed to music (Figure 2). Based on the SRP results, both versions of the music in conjunction with the PACER test produced enjoyment and significantly more motivated students, but did not directly result in higher PACER scores. Even if a student performed better without any music, the SRP results indicated that the students did not necessarily enjoy the activity. Mohammadzadeh, Tartibiyan, & Ahmadi (2008) similarly found that exercising to music makes the exercise more exciting and pleasant which causes a statistically significant increase in performance- a characteristic essential for continued support of public school physical education.

If physical education teachers want students to enjoy physical activity and continue to be active outside of class, teachers could try to incorporate mild and high tempo music into physical education classes. Classroom management skills can also utilize music, such as activity starting and stopping when the music is started and stopped. If students know that they cannot begin until the music starts and that they must get into the freeze position when the music is stopped, it eliminates the teachers need to yell or blow a whistle. Music, as a powerful passive distracter, can cause excitement and distraction (Dorney, 1992), so that the amount of concentration on the actual physical exercise and the perceived exertion rates decreases (Mohammadzadeh, Tartibiyan, & Ahmadi 2008).

Suggestions for Further Research

A longitudinal study could be carried out by collecting the PACER data at the beginning and end of each academic year at the same school and/or the original students could be tracked each year. Trends could be investigated in students throughout the year(s) as well as tracking their progress from the beginning of the year to the end. Significant results may include how students' attitudes toward the variation of the tempos change over the years and how both male and female physical and mental maturation play a role in the PACER and SRP results. A future study could also focus more specifically on students' attitudes toward the use of music, including personal taste in music, as a passive distracter in the physical education classroom and how it affects enjoyment levels or how music might affect general participation, work rate and learning.

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