The Effect of Four Instructional Formats on Aerobic Fitness of Junior-High School Students

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Abstract

The low level of fitness in junior-high school students is an area of great concern. An important, but misunderstood, part of the physical education curriculum is the development of aerobic fitness. What is the best way to go about developing aerobic fitness? Four groups of primarily Caucasian (79.9%) Grade 8 and 9 students (n = 144), attending a large Grade 8-12 school in a suburban west coast Canadian city were tested using a pre- and posttest comparison of one of four instructional formats to determine which produced the greatest increase in aerobic fitness as measured by two timed 2400 meter (1.49 miles) running tests 10 weeks apart. A secondary goal was to see if there existed any difference between boys and girls in fitness attainment. The results indicated that the group receiving the instructional format with the varied activities showed a significantly greater improvement ($p < .05$) in aerobic fitness than the other three groups. This would support the idea that providing varied activities that are fun and engaging is beneficial in increasing aerobic fitness in junior high school students. The results also showed that there were no significant differences between boys and girls as to treatment method.

Introduction

In this age of fast-food restaurants, video games and the automobile, maintaining or improving a reasonable level of fitness in adolescents can be challenging. One of the most accessible opportunities for addressing the physical fitness needs of children and youth is the school physical education program. School physical education programs could incorporate vigorous physical activity, and improvements in the cardiorespiratory endurance component of physical fitness could be achieved by children who participate in such programs. The problem that needed to be addressed was, "What was the best way to incorporate vigorous physical activity into the physical education class in order to improve aerobic fitness?"

Literature Review

The importance of fitness of junior high school students cannot be denied. Adult habits and attitudes in the realm of fitness are often continuations of patterns established during the juvenile years (Canadian Paediatric Society, 2002). Unfit and/or obese children are at an increased risk for "hypertriglyceridemia, hypercholesterolemia, hyperinsulinemia, type 2 diabetes mellitus, hypertension, respiratory disorders, orthopedic problems and psychological problems during their youth." (Berensen & Epstein, 1983 Canadian Paediatric Society, 2002).

Sallis, Prochaska, and Taylor (2000) have reported that numerous studies of youth show that adolescent activity and fitness levels decline as the child ages. The research that has been done shows that the total daily energy expenditure per kilogram of bodyweight diminishes at a rate of almost 50% for both boys and girls between the ages of six and 14 years (Rowland, 1990). At age five or six, youngsters are entering school and the amount of free time in which they can be physically active is reduced. As they enter junior high or middle school, homework considerations

further reduce the time available for free play. The influx of popular sedentary activities such as video games and computers help to lure many youth away from more healthy pursuits. At 16, many adolescents are getting their driver's licenses and as they reach their late teens, riding in a car tends to replace bicycling or walking as the primary means of transportation.

This movement toward a sedentary lifestyle is corroborated by the findings of Kemper (1994) who showed decreases in total activity, using a weighted score of duration and intensity, declined by 12% for girls and 23.5% for boys between the ages of 13.5 and 16.5. Not only is daily energy expenditure decreasing but also the "quality" time of exercise necessary for the improvement of aerobic fitness.

A study by McKenzie et al. (2000) showed that by Grade 8, 27% of boys and 40% of girls had no out-of-school vigorous activity. Sallis (1993) has determined that during the adolescent years, girls reduce their activity level by 7.4% per year and boys by 2.7%.

If fitness development were to take place, it would seem that physical education class is an optimum place to start. "For families who do not have community resources for physical activity, the school physical education curriculum is the one place where all children have the opportunity to be physically active" (McElroy, 2002).

Ideally, each student would participate in fitness activities that require prolonged physical activity, using major muscle groups, for a minimum of 15 to 20 minutes, three times a week, at a heart rate approaching 70-85% of maximum (Corbin & Lindsey, 1994; Coaching Association of Canada, 1987). Some examples are running, cycling, swimming or cross-country skiing. Facilities to participate in all but the running are beyond the reach of most schools either due to cost (purchasing a bicycle, going to a swimming pool) or inappropriate climatic conditions (cross-country skiing). The development of aerobic fitness, where it has been done, therefore tends to be limited to running in one form or another.

Traditional teaching methods and curricula that are common to physical education programs are not necessarily providing the students with experiences that are enjoyable, meaningful or beneficial (Graham, 1995). In a study of Canadian and American youth's motivations for participation and dropping out of sport, Wankel and Kreisel (1995) showed that fun is one of the most important reasons for continued involvement. The more entertaining and engaging the activity is perceived to be, the higher the correlation to the continued participation of the child. One approach was developed and tested for the Albuquerque Public Schools and the Lovelace Medical Foundation (Phillipp, Piland, Seidenwurm & Smith, 1989). It was conducted over the summer, and concentrated upon community-based opportunities for performing physical fitness activities and other related concepts. The results indicated that there was little difference between the control group and the experimental group except for the test of aerobic fitness—the 1.5 mile run. While the authors suggest several reasons for the similarity of results (peer pressure, gender, family history, general interest, resources) it is worth noting that the one area of gain was aerobic fitness. This would suggest that alternatives to the traditional method of "go run" might be worth investigating further.

For the physical education teacher, learning styles are important considerations in lesson planning and curriculum implementation. A task-oriented child is one who tends to derive satisfaction from a more cooperative approach, is more intrinsically motivated, and would participate for reasons of self-improvement (Duda, 1993). An ego-oriented child is highly competitive and perceives winning as the most important facet of sport or physical education and is particularly motivated by extrinsic factors such as awards, recognition and accolades derived from the ability to demonstrate his or her superiority over others (Duda, 1993).

Several researchers, including Sallis et al. (2000) and Weiss (2000), have proposed models

for encouraging youth to become physically active and have addressed the issues of enjoyment, efficacy and support. Among those physical education teachers who strive to develop aerobic fitness, one approach has been to send the students for a run of a predetermined time while encouraging their charges to try and go a little farther or a little faster with each succeeding effort. This would aid in helping the students develop their aerobic fitness and caters to the task-oriented students who enjoy the benefits of seeing themselves progress. There may be some benefits for the ego-oriented students who might strive to go the fastest or furthest overall.

A second approach might be to regularly run the students the same distance as they might expect to see on the evaluation (i.e., "teaching to the test"). Those who were more motivated, gifted or better prepared in this area would finish ahead of the others. This would appeal to the ego-oriented participants but might be a significant deterrent to the others whose self-esteem may be slighted by a comparatively poor showing.

The drawback to both of these methods is that the novelty soon wears off. Either might be interesting for a short time but to show gains in aerobic fitness, the treatment must be applied over a period of 10-12 weeks (Coaching Association of Canada, 1987). Since student engagement is important, another possibility is to have the students design the activities. Given instruction in the fundamentals of aerobic fitness development, would the students be able to design appropriate drills and activities that would result in aerobic fitness development? The result could be a variety of activities depending on whether the task- or ego-oriented factions were involved.

The challenge, therefore, is to design an instructional format that combines the best of both worlds, ego-driven and task-driven, and present it in a way that would be fun, interesting and engaging.

Research question and hypothesis

The purpose of this research was to determine if the improvements in aerobic fitness using a varied activities approach would be superior to the results obtained through the "go run", the "teaching to the test", or the student-designed model as measured through the results of a 2400-meter timed run, and to see if gender influenced the results.

Given the importance of developing aerobic fitness, it is important to find the best instructional format or interventions that will result in the greatest gains during the course of a physical educational unit or program. The hypothesis was that a series of engaging activities designed to be fun yet productive would result in the greatest improvement in aerobic fitness over a ten-week period and that these gains would be equal in both girls and boys.

Methodology

Participants

The sample population for the research was 144 Grade 8 and 9 students (73 male, 71 female) enrolled at a large (1500+) junior-senior (Grade 8-12) high school. The school is situated in a middle-class suburb of a major west coast Canadian city. The students were primarily Caucasian *(n* = 115*)* and rest of Native *(n* = 19) and Asian ancestry *(n* = 10).

Instrumentation

Both the pre- and posttests required only a simple timed 2400-meter run, common to most physical education programs. All classes were taught and the data were collected by the researcher, a physical educator with 28 years experience. Since the researcher was the teacher of record for all of the classes involved, he was able to assure that all groups followed the established protocol as closely as possible. Lesson

plans were verified by colleagues to ensure that they were appropriate for each type of format.

Procedure

In this quasi-experimental study, using a cluster random sampling design, classes of students were randomly assigned a certain protocol. While it would have been better to randomly assign each student to a certain condition, it was felt that this process would have been too unwieldy to administer, insofar as there would be a need for four separate lessons simultaneously in each class. Permission for the study was granted by the Principal of the school and by the Assistant Superintendent of the school district and a Human Subjects Review Approval was obtained.

The project took place over a period of 10 weeks, beginning with a pretest run of 2400 meters on the school's 400-meter track to determine a baseline for future comparisons. The students were explained the importance of pacing themselves and encouraged to do their best. The 2400-meter run was chosen as it is a common measure of aerobic fitness (It was used throughout the school district in question and in the Canada Fitness Tests (Government of Canada, 1984) for junior high aerobic fitness measurement. The classes involved were randomly assigned to one of four conditions. In order to assure that the groups were starting from an equal footing the boys' and girls' pretest 2400-meter times were analyzed using ANOVAs. There were no differences found to exist between the groups at the start of the treatments.

All groups started each class with appropriate and identical warm-up activities. The interventions took place each physical education class for the duration of the project. After the fitness intervention at the beginning of each 76-minute physical education class, the students engaged in skill development in the areas of volleyball and badminton. These activities were chosen as they had somewhat similar aerobic demands and, it was hoped, would not unduly affect the results of the experiment. Since each class did the same two activities, any effect on aerobic fitness should have been relatively equal.

The control group (CG) was given 15 minutes to run at their own pace using the school track and adjoining park area. They were encouraged to do their best, but no restrictions were attached as to the minimum/maximum distance that had to be covered. This was not atypical of aerobic fitness practice in many junior high schools.

The "teach to the test" group (TT) was assigned to run 2400 meters on the track to the best of their ability. They were encouraged to do their best, but no limit was put on how long they could take. They had to, however, have completed the 2400 meters before proceeding on to the rest of the class activities.

The choice group (CH) was given a series of lessons wherein the principles of aerobic fitness development and maintenance were taught. The students were then assigned, in groups of two, to prepare an appropriate activity that would apply the lessons learned with the goal of improving aerobic fitness. Each period, one group of students was responsible for presenting their activity and the class would then put it into action for approximately 15-20 minutes. When every group had presented, there were still classes to be held and the students could choose one of the previously presented activities to use for that day's fitness training. Some of the choices included aerobics, dance and martial arts warm-ups, games such as "British bulldog" and tag, and exercise circuits.

The variable activity group (VA) participated in a wide variety of training exercises (trail running, fun runs, orienteering, relay races, games, and drills) designed to incorporate and develop aerobic fitness. These activities are outlined in Appendix A. Some activities were used more than once.

The school timetable was of an alternating-day format, meaning that, on average, the students had physical education every second school day.

Data Collection and Analysis

Pre- and posttest times were collected by the researcher for 2400-meter runs on the school's 400-meter track. Both pre- and posttests were run during each class' assigned physical education period. The times were examined to determine which group had made the greatest gains in aerobic fitness.

An ANOVA was conducted (with a Dunnett C post-hoc test) to evaluate the relationship between the interventions and the improvement in aerobic fitness. The independent variable (type of intervention) included four categories: varied activities, student-chosen activities, teach to the test and a traditional run group. The dependent variable was the difference between the pre- and posttest times on two 2400-meter runs. The results were also examined to determine if there were any differences between genders.

Results

The results of the pre- and posttest differences on the 2400-meter run are summarized in Figure 1. When the results of the two tests are examined the VA group showed a mean improvement of 135.71 seconds; the CG group showed an improvement of 88.92 seconds, the CH group 86.62 seconds and the TT group an improvement of 60.74 seconds (Figure 1). Overall the mean improvement was 98.56 seconds. The standard deviations were exceptionally large, however-98.81,48.72, 52.91 and 54.45 seconds for the VA, CG, CH and TT groups, (79.96 seconds overall) indicating the results were widely distributed (Table 1).

The ANOVA was significant for the different groups $F(3, 136) = 5.65$, $p = .001$, but not for gender $F(1, 136) = 2.94$, $p = .09$ or for group/gender interaction $F(3, 136) = .38$, $p = .77$. Follow up tests were conducted to evaluate pairwise differences between the means of the groups. Because the differences between variances of the groups were large, a Dunnett C post-hoc test was chosen. The results showed that there was a significant difference ($p < .05$) between the improvements made by the VA group when compared to each of the other three groups. There were no statistically significant differences between the other three groups (Table 2).

As for gender, while differences between boys and girls were noted, they were not statistically significant. Figures 2 and 3 illustrate the distribution of time differences in the various groups for girls and boys respectively. An interesting point was that the VA and TT groups each had two students (one male, one female) whose times increased between the pre- and posttest. All times improved in the CG and CH groups.

Discussion

The results of this research indicate that there may be a solution to modifying the fitness habits of junior high students insofar as their aerobic conditioning is concerned. Statistically significant differences were found between the VA approach and the TT, CH, and CG groups.

There are several items to be considered. The results would support the suggestions of Ward, Everhart, Dunaway, Fisher, & Coates (1998) that enjoyable and challenging activities would produce high student interest, motivating them to perform fitness-oriented activities and improve their fitness levels. There is an inherent value in spending the extra time, energy and resources to plan and implement a varied activity instructional format. The VA format takes considerably more effort to use. IT and CG formats are overwhelmingly easier to set up, control and administer. The CH group requires that the students have a grasp of cardiovascular fitness fundamentals, although this is, or should be, a learning objective with all groups at this level. However, in terms of greatest return on investment, it would be worth implementing the VA format.

It is interesting to note that the second best improvements in raw time were made in the Control Group. The author can only suggest that because everyone was going to run for the same

Figure 1. Mean improvement time (in seconds) between 043- and posttest 2400-meter runs

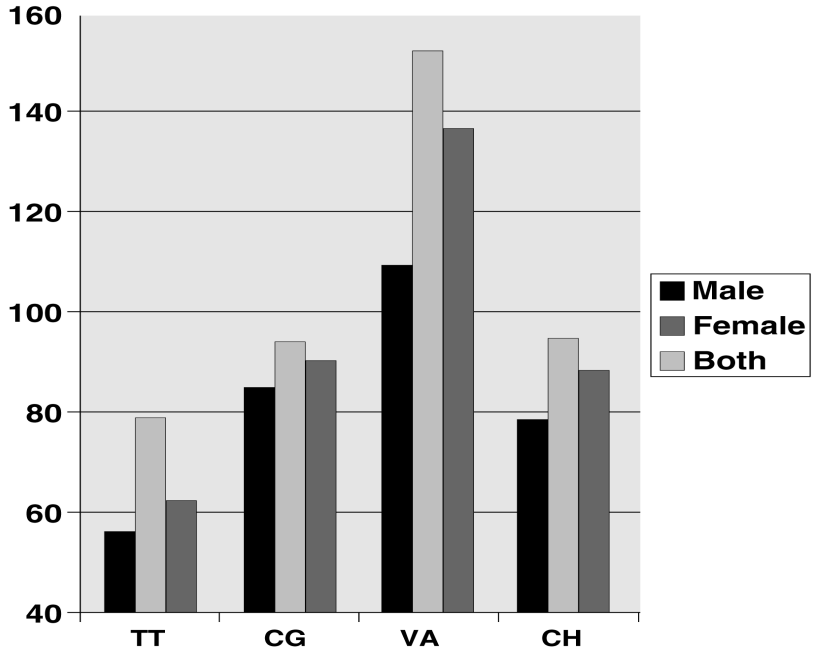


Table 1.

Difference in Times Between Pre- and Posttest 2400 Meter Runs.

Descriptive Statistics

Dependent Variable: difference

GROUP #	GENDER	Mean	Std. Deviation	N
TT	Male	54.52	50.086	31
	Female	78.27	64.604	11
	Total	60.74	54.454	42
CG	Male	83.92	53.925	12
	Female	93.54	45.099	13
	Total	88.92	48.722	25
VA	Male	108.29	62.301	21
	Female	152.17	112.987	35
	Total	135.71	98.807	56
CH	Male	77.00	63.285	9
	Female	93.83	45.216	12
	Total	86.62	52.909	21
Total	Male	77.59	59.359	73
	Female	120.13	92.224	71
	Total	98.56	79.956	144

Table 2
Dunnett C Test of time djfferences

Multiple Comparisons

Dependent Variable: difference Dunnett C

(I) GROUP #	(J) GROUP #	Mean Difference (I-J)	Std. Error	95% Confidence Interval	
				Lower Bound	Upper Bound
TT	CG	-28.18	12.867	-63.23	6.87
	VA	-74.98*	15.650	-116.57	-33.39
	CH	-25.88	14.279	-65.25	13.49
CG	TT	28.18	12.867	-6.87	63.23
	VA	-46.79*	16.410	-90.90	-2.69
	CH	2.30	15.108	-39.73	44.33
VA	TT	74.98*	15.650	33.39	116.57
	CG	46.79*	16.410	2.69	90.90
	CH	49.10*	17.540	1.49	96.70
CH	TT	25.88	14.279	-13.49	65.25
	CG	-2.30	15.108	-44.33	39.73
	VA	-49.10*	17.540	-96.70	-1.49

Based on observed means.
* The mean difference is significant at the .05 level.

Figure 2. Distribution of girls' time improvements from pre- to posttest 2400-meter runs (in seconds).

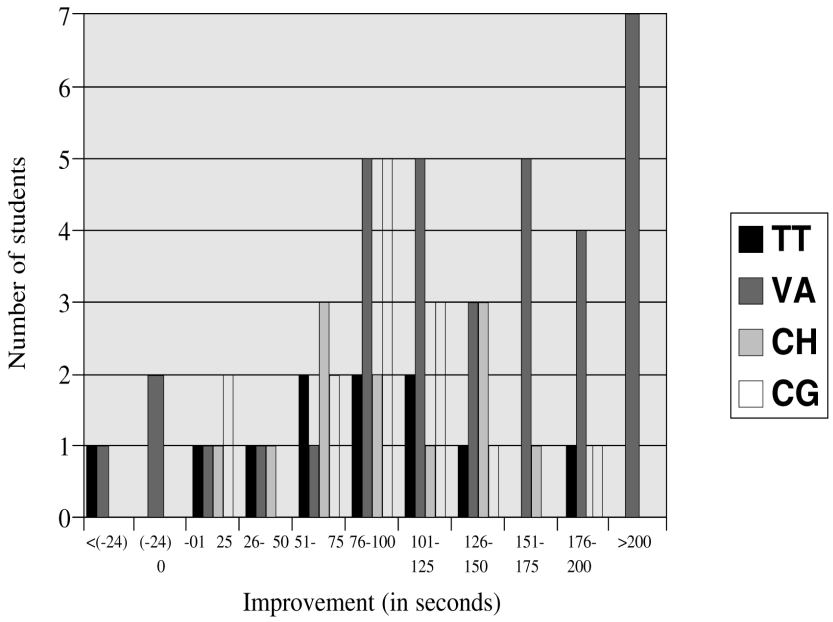
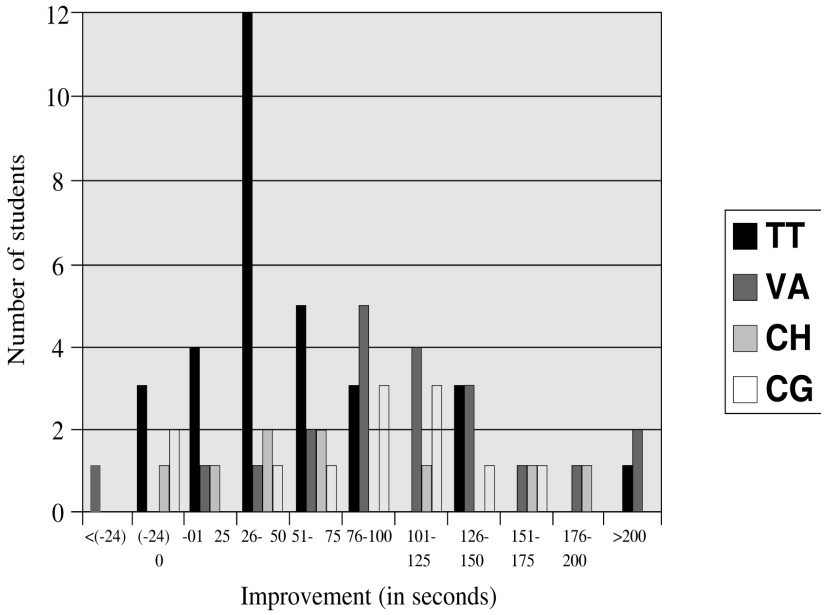


Figure 3. Distribution of boys' time improvements from pre- to posttest 2400-meter runs (in seconds).



length of time and that distance was not a factor, the students all felt that they were equal and perhaps were more motivated. Some students could also run with their friends, if they so chose, even if they were of different abilities, because time, not distance was the controlling factor.

The results of the TT group seem to run contrary to the supposition that instructional activities should be aligned with performance evaluations. One possibility is that the repetitive nature of the activity led to a lack of interest and a consequential loss of performance. The TT group would also have had some students finishing well ahead of others in an attempt to get it over with quicker and could have caused some students of lesser ability to feel intimidated and not wanting to expend as much effort. Alternatively, some of the more talented runners may not have exerted themselves and instead chose to run at a more leisurely pace (with their friends) thereby losing some of the training effect.

The poor results by the CH group were surprising, in light of the fact that they had the opportunity to choose activities that appealed to them. It is possible that the comprehension of the factors necessary for aerobic improvement was not adequate and therefore the choice of activities did not adequately address the parameters needed for fitness improvement.

While not statistically significant, it is worth noting that in all interventions, girls improved more than boys. There could be many causes for this, including but not limited to, motivation, fitness levels at the beginning of the interventions, or the age of the students. Kemper (1994) and Kemper, Ferschuur, and de Mey (1989) have shown that girls at this age are peaking as far as aerobic fitness is concerned, while boys continue to develop for several more years.

For future considerations, there are several changes that could be made. First the project should be repeated with the CH group having a

better understanding of the conditions needed to effect cardiovascular fitness improvement. Use of a random and a larger sample with equal number of students in each group would be ideal, but may be impractical, since examining intact classes is more feasible. A matched pair format may be possible but under the circumstances may not be practical. Participation in outside interscholastic or extra-curricular aerobic activities (such as cross-country running, soccer and hockey) could be examined to determine if they would present confounding variables. Since all the classes were from the same school, it is possible that some groups may have been influenced by what the other classes were doing. Using other instructors for the research would also have increased the validity of the results. The use of multiple institutions would have eliminated these problems. Furthermore, an examination of the reason for the outlying results should be made to see what, if anything was the cause of the extreme range of some scores.

The procedure has opened up a number of questions that are worth investigating. How does the motivation level of the students affect their performances in the testing? A comparison of results taking into account intrinsic and extrinsic student orientations may be worthwhile. It would also be useful to find out the opinions and/or preferences of the students of one instructional format as compared to another.

The type and format of the activities in the Varied Activities group would parallel the thinking of Darst, van der Mars, and Cusimano (1998) who advocate "using an expertly taught program that includes a wide variety of novel and challenging introductory and physical fitness activities." A list of possible activities is suggested in Appendix A. This could be modified and adapted as necessary.

Conclusion

This study was able to support the hypothesis that a series of engaging activities designed to be fun, yet productive, does result in the greatest improvement in aerobic fitness over a ten-week period. While the girls did improve more than the boys, the gains were not sufficient to be statistically significant. Further research is needed in the area of junior high aerobic fitness if we are to effect important changes in their health and fitness patterns.

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Appendix A

Activities used by the Varied Activities Group

For most of the activities, the students participated in teams, which were randomly chosen at the beginning of the unit. The students stayed together in these teams for the duration of the unit.

Poker run	Repeatedly run a 300-400 m. course. Each team "leader" gets a card each time (s)he passes the start. Others get a card after 4 laps non-stop. Run for 15 minutes. Team members put all cards together and choose best 5 cards. Best poker hand wins.
The Amazing Race ©.	Similar to the TV show. Clues indicate where answers (and next clues) are hidden. Object is to collect all the answers and get back to the start first.
Team cross-counriy run	Teams run a 2 km mini-race over varied and fun terrain- hills, pathways through the park, etc.
Watermelon run	Out and back run. (2km total) Have watermelon slices (or other treat) available *at* halfway point and finish.
Terry Fox Cancer run	A 3-4 km run used as a fund-raiser for cancer research.
Easter egg hunt	Hide Easter eggs or other wrapped treats in various locations on the school property.
Capture the flag	Same as the regular game. The most fun is when there are brush, trees and obstacles.
Scrabble ® run	Similar to poker run but runners collect Scrabble letters. Use all the letters to make as many words as possible. Add the point value of the letters used.
Orienteering	This can be done on or off school property depending upon age, maturity and ability of students. (Approx. 3 kin)
Track and Field training	Different training methods- relays, fartlek, intervals as used by track and field athletes- various distances
Activity run	Run to bowling, mini-golf or other activity. Play a game run back. (approx. 1.5 km each way)
Partner cross-country run	Similar to regular cross-country but pair up the students- and run in teams of two. (Approx. 2 km)
Destination run	Run to Dairy Queen or 7-1l, have a treat, and run back. (Approx 1.5 km each way)
Mini-Olympics	Organize a Mini-Olympics with distance races and relays. (1500m, 3000m, 2000m steeplechase)
Obstacle Course	Set up an obstacle course in the field and run several laps of it (4 laps @ 500m/lap)

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