

# Fit-Breaks: Incorporating Physical Activity Breaks in Introductory CS Lectures

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## ABSTRACT

University can be a difficult, stressful time for students. This stress causes problems ranging from academic difficulties and poor performance, to serious mental and physical health issues. Studies have shown that physical activity can help reduce stress, improve academic performance and contribute to a healthier campus atmosphere physically, mentally, and emotionally. Computer science is often considered among the most difficult and stressful programs offered at academic institutions. Yet the current stereotype of computer scientists includes unhealthy lifestyle choices and de-emphasizes physical activity.

This paper analyzes the effects of introducing short periods of physical activity into an introductory CS course, during the normal lecture break. Contrary to the stereotype of CS students, participation was high, and the students enjoyed these Fit-Breaks more than alternative break activities. This small injection of physical activity also had a measurable impact on the students' overall satisfaction with life, and may have had positive impacts on stress, retention, and academic performance as well as improved student perception, especially in areas that are traditionally problematic for female computer science students.

Fit-Breaks are low-cost, easy to replicate, and enjoyable exercises. Instead of sitting quietly for ten minutes staring at a phone; stretching, moving, and getting a short burst of physical activity has a positive benefit for students. And the good news is: they actually enjoy it.

## CCS CONCEPTS

• **Social and professional topics** → **Computing education; Computer science education; CS1;**

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## KEYWORDS

CS1, Stress, Wellness, Attention, Physical Activity, Lecture Delivery

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## 1 INTRODUCTION

In Fall 2016, we piloted a program at the University of Toronto Scarborough that integrated physical activity into introductory computer science (CS1) lectures, and measured the impact on student outcomes. During the ten-minute intermission in lecture (standard practice for lectures lasting 2 hours or longer), students were led through “Fit-Breaks”: short bursts of easy-to-follow exercises and stretches. The goal of the activity was to provide students with a healthy break, allowing them to reset and refocus their attention, while simultaneously helping to relieve the stress of a fast-paced lecture experience. We set out to transform the classroom experience by utilizing weekly Fit-Breaks as a means to promote healthy activity, reduce stress, improve focus, aid in retention of lecture material, and include an enjoyable mid-lecture activity which may also help combat the traditional stereotype of computer scientists as unhealthy and overly technically focused.

This study uses an easily replicable, simple classroom intervention to see if physical activity can have a positive impact on well-being, classroom experience, stress, attitudes towards physical activity, and academic performance. By using a controlled study design across multiple randomly assigned lecture sections with the same instructor, assignments and exams, we aim to analyze the impact of these Fit-Breaks on multiple areas of student experience by assessing factors including grades, retention questions, peer-reviewed measures of mental health, and lecture experience reports.

## 2 BACKGROUND

Students attending post-secondary education are entering with a host of stressors and mental health issues that are impacting their ability to learn. In 2016, the National College Health Assessment Survey of 27,787 North American undergraduate students found that 61.9% reported overwhelming anxiety, while 39.1% reported

that they felt too depressed to function in the last 12 months [1]. Data from high school students in Ontario provides additional concern: in 2016, 34% of adolescents ( $N=10,400$ ) reported moderate to serious psychological distress - a 10% jump from 2013 [5]. Stress and mental health issues can manifest in a myriad of ways, including poor academic performance, lower classroom engagement, course withdrawal, social isolation, and physical health concerns [15, 32].

Computer science courses are notoriously difficult, with an average failure rate of 33% in a global sample [3]. There are many reasons why students drop introductory CS courses, including those related to prior programming experience and academic capacity, but also peer groups and levels of stress [29]. Researchers in computing education have noted these concerns, with a strong history of pedagogical research exploring the concerns of undergraduate CS students [30]. However, most research has primarily focused on academic interventions, such as adjusting assignments, introducing new technologies, and changing lecture sizes [33]. In fact, Haggis [20] found that 98.9% of existing experimental research looked at teaching modalities and instruction; although holistic models are starting to enter the forefront [23]. If CS pedagogical interventions do include psychological elements, they are primarily focused on the constructs of learning and motivation [2, 27].

Computer science education suffers from a strong stereotype threat [25, 26, 28]. One aspect of that image is the perception of computer science as a purely technical and non-creative field, with little social relevance or broader applicability [31]. Common stereotypes of computer scientists are as 'loners' with poor social skills and unhealthy lifestyles [4, 19], and these perceptions can cause female students and students from underrepresented groups to feel excluded from the computer science community - ultimately resulting in lower participation rates [10, 35].

When considering methodologies to transform CS education, physical activity is often an afterthought; a hobby that students can engage in extracurricularly. However, physical activity may be an underexplored and potentially emerging classroom tool that can lead to a myriad of student benefits. In a large review, Carek et al. [9] noted that habitual exercise correlated with a heightened level of life satisfaction, cognitive functioning, and psychological well-being, while physical inactivity was associated with the development of mental illness. Similar effects have been found by other researchers in general population-based samples [8, 12, 18, 22], and fitness intervention settings [17, 34]. These psychosocial benefits are in addition to the many established physical health benefits from physical activity [16].

There have been attempts to measure the impact of physical activity in young adults, which have led to similar positive results. Bray and Born [7] found that undergraduates who were insufficiently active reported higher levels of fatigue and lower levels of vigour compared to students who continued to be active in university. Other studies have found that participation in physical activity also helps facilitate the creation of a healthier campus environment by building student engagement and a sense of camaraderie [21, 36]. However, most of these studies either do not manipulate levels of physical activity, instead relying on correlates with surveys, or involve very intensive interventions measured in controlled lab settings, with limited discussion on implementable strategies to achieve real world impact.

**Table 1: Lecture Schedule for Experimental and Comparison Groups**

	Hour 1	Hour 2	Hour 3
Ex Group 1	Mo 1-2pm	Th 9-10am	Th 10-11am
Ex Group 2	Tu 3-4pm	Th 3-4pm	Th 4-5pm
Ex Group 3	Tu 7-8pm	Tu 8-9pm	Tu 9-10pm
Comp Group	Mo 12-1pm	We 1-2pm	We 2-3pm

**Table 2: Descriptive Data for Participants' Demographic Characteristics**

	Comparison (N)	Fit-Break (N)	Total (N)
Total Sample	45	121	166
Gender			
Female	9	25	34
Male	36	96	132
Ethnicity			
White	4	18	22
East Asian	24	62	86
South Asian	13	24	37
Black	1	2	3
Arab	2	0	2
Southeast Asian	1	13	14
Other	0	2	2
Student Status			
Domestic	38	100	138
International	7	21	28

### 3 METHODOLOGY

The study was conducted in CSCA08: Introduction to Computer Science I, a course with 750 students across 5 lecture sessions. The course serves as a prerequisite for all students intending to pursue CS degrees, and is mostly taken in the first semester of the first year for any student in the CS program. A small number of students take the course as part of non CS programs (mathematics and statistics). The university also offers a CS0 course for non-degree students.

#### 3.1 Experimental Groups

Students were randomly allocated to lecture sections and were only allowed to switch between sections if space was available. Four of the five lecture sections in the course were taught by the same instructor, and of those four, three had a lecture schedule that included a 1-hour lecture on either Monday or Tuesday, and a 2-hour lecture on either Wednesday or Thursday, with the fourth being a 3-hour evening lecture. The lecture section taught by a different instructor was excluded from the study. All lecture sections had the break activity between the second and third hour of lecture during the week.<sup>1</sup> The lecture schedule can be found in Table 1 and the demographic information for the study participants can be found in Table 2.

The instructor for all four sessions being studied (also the course coordinator in charge of designing all assignments, tests, and choosing course material), has four years of experience teaching the same course to over 2000 students. All lecture materials, examples and

<sup>1</sup>It is customary at the University of Toronto to have a 10-minute break in lectures lasting 2 hours or longer. Breaks are not generally given during 1-hour lectures.

practice problems were kept consistent across all lectures, and all other course components (assignments, exams) were entirely independent of lecture section. The Fit-Break instructor was a student employee of the Department of Athletics and Recreation.

Students were provided the opportunity to earn a bonus 2% grade for completing a minimum nine of a possible twelve weekly online questionnaires. It was made clear that the bonus was gained from completion of the questionnaires, regardless of the answers given or the participation in the actual break activities. In the interest of disclosure, it should be noted that both the course instructor and Fit-Break instructor are primary investigators for this study. It was made clear to the students that the course instructor had no access to the results of the survey until after all course grades were submitted, and even then would not have access to personally identifiable responses. All data collection activities were conducted by researchers not directly affiliated with the course.

### 3.2 Experimental Setup

One lecture session was randomly chosen to be held as a comparison group. Students in this lecture section were told that the purpose of the activity was to assess the impact of different types of music during the lecture break, and therefore each week a different genre of music (classical, rock, jazz, etc.) was played by a research coordinator through the classroom audio system for ten minutes. The evening lecture was specifically excluded from this choice, as it was not clear at the outset of the experiment whether the evening nature of the course would have had a significant impact on the outcome.

The remaining three lecture sections were combined to form the experimental group. In these lectures, between hours 2 and 3, a Fit-Break instructor would lead exercises and stretches during the ten-minute lecture break.<sup>2</sup> The first half of the Fit-Break was focused on raising the heart rate through cardio-based or large muscle group exercises (jogging on the spot, boxing jabs, wall-sits, lunges, etc.) while the second half focused on stretches to combat sedentary behaviour (focused on the neck, core, shoulders, hips, etc.). The exercises and stretches were verbally described and visually demonstrated. Several versions of the routine were offered to accommodate students of all ability levels. All Fit-Break lecture sections received the same exercise and stretch routine each week. Although the Fit-Break instructor remained constant, the routine varied on a week-to-week basis following the general pattern described above for the purpose of keeping students interested, teaching them various exercises and stretches, and encouraging more self-awareness.

### 3.3 Measurements

All participants were asked to complete weekly online questionnaires within 24 hours of their break activity. The questionnaire for week 1 served as a baseline measure containing basic demographic questions, attitudes towards physical activity, and the following scales: Perceived Stress Scale (PSS)[11], Satisfaction with

Life Scale (SWLS)[13], and International Physical Activity Questionnaire (IPAQ)[6]. All three scales were chosen as well-validated, stable measures across multiple samples ranging in culture, age, and health status. Questionnaires for weeks 2-11 contained weekly measures of PSS, SWLS, reflections on classroom experience, and course material retention questions. Four retention questions were generated by the primary course instructor and provided to the research coordinator to include in the questionnaires each week. Two retention questions pertained to the material covered before the lecture break and two questions pertained to the material covered after the lecture break. In the final week of class, week 12, the questionnaire mimicked the scales of week 1 as a post-assessment.

Students who did not complete both week 1 and week 12 were excluded from the study as it contained the pre- and post-assessment. The threshold for weekly responses was decreased to a minimum of seven total responses. Participants who did not meet this criterion were also excluded from the study. Incomplete questionnaires were not included in the study.

### 3.4 Statistical Analysis

The mean and standard deviation were presented as descriptive statistics and can be found in Table 3. A repeated measures analysis of variance (ANOVA) was applied for SWLS and PSS to estimate the differences of the break intervention on the Fit-Break and comparison groups in week 1 and week 12 (the final week of the semester). The Box Test of Equality of Covariance Matrices ( $p > 0.001$ ) and Levine's Test of Equality of Error Variances ( $p > 0.05$ ) were checked to verify assumptions about our sample. In the case of significant ANOVA results, independent sample t-tests were used to perform post hoc comparisons between groups. The partial eta-squared value ( $\eta_p^2$ ) was presented as an effect size for significant main effects. Furthermore, independent sample t-tests were used to check for differences in enjoyment and grades.

## 4 RESULTS

Data for both the Fit-Break and control group was collected and analyzed. Metrics of interest were: student enjoyment of the break activities (7-point Likert scale, average across all weekly responses); Satisfaction With Life Score (SWLS) (25 point scale, self-reported in the first and final weeks of the term); Perceived Stress Scale (PSS) (40 point scale, self-reported in the first and final weeks of the term); Final grade achieved in the course (Out of 100, not including study participation bonus); and Retention scores (Out of 100 for both pre and post test, average across all weekly responses). The findings are summarized in Table 3.

### 4.1 Student Enjoyment

An independent-samples t-test was conducted to compare break enjoyment in the Fit-Break groups versus the music-listening comparison group. Results, shown in Figure 1, indicated that levels of break enjoyment were significantly higher in the Fit-Break group ( $M=5.31$ ,  $SD=1.07$ ) than the comparison group ( $M=4.84$ ,  $SD=0.96$ ),  $t(163)=2.56$ ,  $p=0.011$ , as seen in Table 3. Follow-up analyses conducted separately among women and international students showed

<sup>2</sup>The 3-hour evening lecture had a traditional lecture break between hours 1 and 2 with no break activity. Separate analysis of the evening session showed no statistically significant difference in distribution on any factors. Therefore, these students were included in our experimental group.

**Table 3: Student Outcomes for Comparison and Fit-Break Groups by Measure**

	Comparison M (SD)	Fit-Break M (SD)
Enjoyment (1-7)		
<b>Total Sample*</b>	<b>4.84 (0.96)</b>	<b>5.31 (1.07)</b>
Female	4.94(0.75)	5.22 (1.00)
International	5.10 (1.18)	5.32 (1.07)
SWLS (1-25)		
<b>Total Sample (Pre - Post)*</b>	<b>22.21 (5.41) - 21.93 (6.03)</b>	<b>20.71 (5.56) - 22.86 (6.42)</b>
Female (Pre - Post)	22.25 (3.11) - 23.25 (5.09)	19.76 (6.47) - 22.16 (5.61)
International (Pre - Post)	20.67 (6.68) - 20.00 (4.29)	19.19 (3.98) - 23.00 (6.75)
PSS (1-40)		
Total Sample (Pre - Post)	17.91 (5.81) - 20.21 (5.57)	17.87 (5.86) - 20.12 (6.13)
Female (Pre - Post)	18.38 (6.28) - 21.00 (5.95)	21.08 (7.67) - 22.68 (6.71)
International (Pre - Post)	21.17 (24.33) - 24.33 (6.15)	18.29 (4.62) - 19.24 (4.05)
Grades (%)		
Total Sample	70.24 (13.43)	72.53 (14.52)
Female	71.46 (18.56)	72.20 (14.68)
<b>International*</b>	<b>60.65 (12.90)</b>	<b>73.75 (13.31)</b>
Retention (%)		
Total Sample (Pre - Post)	68.43 (16.86) - 54.90 (13.33)	68.30 (16.40) - 57.55 (12.67)
Female (Pre - Post)	64.14 (18.54) - 54.10 (18.36)	64.72 (19.42) - 56.99 (16.51)
International (Pre - Post)	64.42 (16.07) - 55.37 (12.11)	72.48 (19.56) - 51.46 (14.50)

Note: \* = statistically significant  $p < 0.05$

similar, though non-significant trends. Specifically, our results suggest that students enjoyed engaging in physical activity during their lecture break more than listening to music.

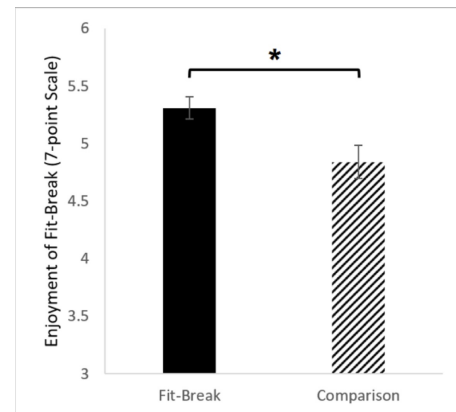
## 4.2 Course Perceptions

All students were asked a series of questions in the final week of term relating to their perceptions of the course. These questions were graded on a 5-point Likert scale with 1 being “Strongly Disagree” and 5 being “Strongly Agree”. Results from this questionnaire can be found in Table 4. While the sample size was too small to provide statistical significance, the data indicates that the Fit-Break activities had a positive impact on several important areas of course perception, particularly among female students. In particular, we found that female students in the Fit-Break group showed improvements in their perceptions of sense of control, enjoyment and perceived usefulness: three areas that are traditionally problematic for female students in CS.

## 4.3 Perceived Stress Scale

A one-way within subjects ANOVA was also conducted to compare the effect of break structure on PSS in the Fit-Break and comparison groups. No significant effect of break structure was found, but a smaller decrease in PSS score means was observed from week 1 to week 12 for the Fit-Break ( $\Delta M=2.25$ ) in relation to the comparison group ( $\Delta M=2.3$ ).<sup>3</sup> This trend continues with female (Fit-Break  $\Delta M=1.6$ ; Comparison  $\Delta M=2.62$ ) and international student

<sup>3</sup>Mean scores were calculated by subtracting the PSS Post-assessment total mean by the PSS Pre-assessment total mean to get a  $\Delta$  score showing rate of change across time.



**Figure 1: Mean difference in responses to “I enjoyed the lecture break activity” with 1 being ‘Strongly Disagree’ and 7 being ‘Strong Agree’ for the Fit-Break and Comparison groups.**

(Fit-Break  $\Delta M=0.95$ ; Comparison  $\Delta M=3.16$ ) subgroups. These results, summarized in Table 3, suggest a larger increase in perceived stress for the comparison group compared to the Fit-Break group, although this finding was not statistically significant.

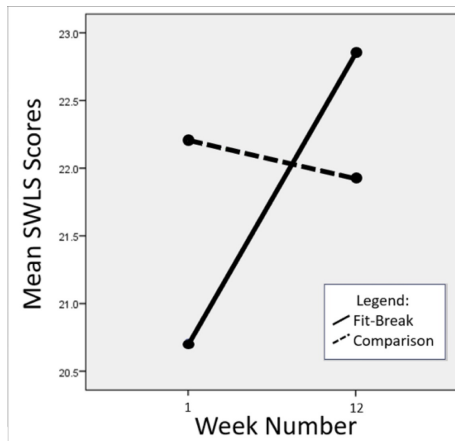
## 4.4 Satisfaction With Life Scale

The SWLS is measured on a 25 point scale with 20 representing a neutral point. A one-way within subjects ANOVA was conducted to compare the effect of break structure on SWLS in the Fit-Break and comparison groups. There was a significant effect of break structure between the two groups, Wilks’ Lambda=0.97,  $F(1,160)=5.66$ ,



**Table 4: Average Agreement with Course Perception Survey Questions by Gender**

Statement	Mean Agreement (All) Fit-Break - Comparison	Mean Agreement (Male) Fit-Break - Comparison	Mean Agreement (Female) Fit-Break - Comparison
"I felt I had the power to change how things were done in this class"	3.03 – 2.96	3.07 – 3.14	2.88 – 2.22
"I enjoyed this course more than the other courses I took this semester"	3.96 – 3.76	3.98 – 3.83	3.88 – 3.44
"I fee this course was more useful to me than other courses I took this semester"	3.94 – 3.84	3.94 – 3.92	3.96 – 3.56

**Figure 2: Mean Satisfaction with Life Scale (SWLS) Scores for Fit-Break and Comparison groups at Pre- and Post-Assessment timepoints.**

$p=0.019$ . An independent samples t-test was used to make a post hoc comparison to ensure that our groups were not significantly different at the beginning of the study. Indeed, there was no significant difference in pre-assessment SWLS scores between the Fit-Break ( $M=20.77$ ,  $SD=5.55$ ) and comparison ( $M=22.29$ ,  $SD=5.37$ ) groups;  $t(163)=1.60$ ,  $p=0.112$ . These results, illustrated in Figure 2, suggest that break structure does impact student reported satisfaction with life. Specifically, our results suggest that when students engage in physical activity during their break, their self-reported satisfaction with life is significantly higher than when they listen to music during their break from pre- (Week 1) to post-assessment (Week 12). However, the effect size is small ( $\eta_p^2=0.034$ ).

Similarly to the student enjoyment data, a follow-up analysis was conducted with female and international student subgroups for SWLS scores. A one-way within subjects ANOVA revealed that these findings were not statistically significant.

#### 4.5 Academic Measures

As summarized in Table 3, an independent samples t-test was conducted to examine the change in final course grade, reported out of a maximum score of 100. International students in the Fit-Break ( $M=73.75$ ,  $SD=13.1$ ) group had a statistically significant difference in their final grades in relation to the comparison ( $M=60.65$ ,  $SD=12.90$ ) group, indicating an effect of break structure;  $t(26)=2.27$ ,  $p=0.032$ .

The female subgroup and total sample also showed higher final grades for students in the Fit-Break group over the comparison group, although these results were not statistically significant.

A one-way within subjects ANOVA was conducted to compare the effect of break structure on retention. No significant effect was found, but results followed the expected trend, with lower numbers indicating a smaller drop-off in retention from the first half to the second half of the lecture. The expected trend was observed in the total sample (Fit-Break  $\Delta M=10.75$ ; Comparison  $\Delta M=13.53$ ) and female subgroup (Fit-Break  $\Delta M=7.76$ ; Comparison  $\Delta M=10.04$ ) but not in the international student subgroup (Fit-Break  $\Delta M=21.46$ ; Comparison  $\Delta M=9.05$ ).

## 5 DISCUSSION & FUTURE WORK

The present findings show that even small weekly bouts of physical activity can have a positive impact on the well-being and satisfaction of students. This real-world evidence builds on the validity of previous studies that used physical activity-based interventions on children or in highly controlled lab settings [8, 12, 18, 22].

For CS educators, these results show that structuring your lecture break, a segment of class time that is often overlooked by instructors, can have an impact on student enjoyment. Instructors use lecture breaks as an opportunity for students to relax and reset their attention. However, students often remain seated during these breaks using a laptop or mobile device, which may have unintended consequences. A study by Lepp et al. [24] found that cell phone use correlated with poor academic performance, increased anxiety and decreased satisfaction with life.

Some instructors at our institution play music during the lecture break, giving students something to listen to for relaxation and enjoyment purposes. Our study shows that students enjoyed engaging in Fit-Breaks more than simply listening to music, suggesting that the introduction of movement activities during the break could be a welcome addition to the classroom.

Of note, finding a statistically significant difference with the Fit-Break group members being more satisfied with their life is a particularly promising finding given that SWLS is a measure of global, not acute well-being, a construct that is difficult to change [14], so even a small improvement is encouraging. Further work replicating this finding, and exploring which components of well-being are modified by physical activity is warranted.

Analyzing the enjoyment and SWLS results by gender and international status showed similar results for all groups. While the numbers were too small to show statistical significance within the subgroups, it is promising to note that female students and

international students both showed similar patterns of enjoyment and improvement on satisfaction with life, indicating that these results are not being driven only by the 'stereotypical' computer science students, and that traditionally under-served groups were also benefitting from participation in the Fit-Breaks.

Although statistically significant findings were not found when stress, course content retention and academic performance were measured, the trends were mainly in the expected direction and warrant further exploration. Of note is the statistically significant finding among grades for international students in the Fit-Break group, who scored 13% higher in the course on average, with variance similar to the comparison group. It should be noted that the sample for both groups was small (21 experimental, 7 comparison). With increased pressure and psychological stressors on international students, the effects of a physical activity intervention could be amplified in this population. Future work exploring this construct further is recommended, especially with a larger sample size.

Similar to SWLS, PSS is a valid, reputable measure of overall, global stress. In fact, the instructions for the scale specifically states: "The following questions will ask about your feelings and thoughts during the past month" [11]. Therefore, given what we know about increasing rates of stress in CS (and undergraduate education more broadly), it is not surprising to see all students increase in stress as the semester went on [1, 15, 32]. However, the fact that we observed the Fit-Break group being slightly less stressed may indicate that just ten minutes of physical activity a week can help protect students. While the effects are relatively small, and may only affect students immediately following the exercise, the results warrant further study, particularly as the overhead is quite low, and the students actually enjoy participating in the activities.

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