# Prior-to-exam: What activities enhance performance?

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**ABSTRACT**

Can instructors impact their student performance by recommending an activity just prior to taking an exam? In this study, college students were randomly assigned to one of three treatment groups (study, exercise, or meditation) or a control group. Each group was given two different types of tests; a traditional concept exam, and a non-traditional hands-on exam designed to test mastery of computer applications. A multiple analysis of covariance (MANCOVA) was conducted. Although the same pattern is seen in both the IT Concepts exam and the Hands-On Computer Application exam, significance was only reached in the latter. The study group performed about the same as the control group. The exercise group performed much worse. The meditation group did better than any other group in the study.

The authors conclude that prior-to-exam activity may be a strong influence in exam performance, especially when the exam is testing a combination of kinesthetic and cognitive information such as that needed for hands-on computer application exams. Further research is needed to determine the parameters for the scope of activities that influence performance.

Keywords: pedagogy, business education, information technology education, learning with technology, exercise and performance, meditation and performance

## INTRODUCTION

Student performance is influenced by a myriad of factors; cognitive ability, prior learning and experience, amount of study, current attention level. Generally, it is thought that if a student has not studied or does not possess the cognitive abilities necessary, there is nothing that can be done to help that student just before a test or exam.

But what if we could improve student performance on tests and exams just by changing the activity they do just prior to taking the exam? Does the activity the student perform during the 15 minutes prior to an exam make a difference in the results of the exam? Can a student boost their performance by studying? By exercising? By meditating?

## SEARCH OF THE LITERATURE

There doesn't appear to have been much research into prior-to-exam activities and their impact on the performance for a student on computer applications exam, either conceptual or hands-on. There have been quite a few studies on the impact of meditation and/or exercise for overall performance and success. Additionally, learning computer concepts and applications has been researched quite a bit over the years since technology has become so ubiquitous in our society. Our search of the literature focused on these three topics: meditation and performance, exercise and performance, and learning computer applications.

### Research on Meditation and Performance

In the seventies, there were quite a few studies on transcendental meditation and its impact on test anxiety. Linden, may have been one of the first to see if students could learn to relax by meditating. They benefited by using meditation to cope with anxiety responses in testing situations. (Linden, 1973).

After a spate of similar studies where self-reported anxiety decreased, more studies looking for objective evidence commenced, especially when compared to other potential anxiety-reducing behaviors. Unfortunately, very little difference in the objective measurement of anxiety could be found. For example, Dr. Kindlon used a difficult and stressful test to determine objective levels of anxiety. He randomly assigned 35 college students to either meditation or napping groups and measured anxiety in three ways: self-report, performance, and physiological indices such as blood pressure. The study concluded that meditation and napping equally reduced test anxiety. (Kindlon, 1983)

While many studies show that the practice of meditation can improve a student's performance, few indicate whether the timing of the meditation has an effect. Fiebert & Mead conducted a study to determine if students practicing meditation before studying and before examinations would perform significantly better than a control group who did not meditate at those times (though they were taught to meditate and asked to do so at other times). The results suggest that the meditation techniques mildly improved academic effectiveness in both the control group and the experimental group, but the students who meditated just before studying and taking the exam did better on the exams than the control group. It appeared that giving the experimental group explicit directions to perform the meditation before study and examination times improved performance. (Fiebert & Mead, 1981)

After a period of decreased attention in the topic in the late eighties and early nineties, new neurological studies identifying important changes in the brain due to meditation renewed interest. Once again, researchers were looking at the impact of meditative and relaxation activities and behaviors to improve performance. (Benson, 1997; Haynes & Zabel, 2004) Stress reducing activities were recommended for adults in business as well as children in school. (McNaughton, 2003; Patterson, Bennett, & Wiitala, 2005; Ryan, 2007)

Fergusson's study of art students demonstrated benefits of meditation on kinesthetic activities and creativity. That study found that field independence (a type of cognition that relies on internally derived information) measurements have been higher for Maharishi International University students who practiced meditation than students who did not. Fergusson cites evidence to support his proposal that a systematic study of the influence of meditation on college achievement in art would be beneficial, and would show a higher ability to focus. (Fergusson, 1993)

Seventy six college students enrolled in a Taijiquan (a type of moving meditation) course displayed increased mindfulness and improved sleep quality, mood, and perceived stress, when compared to a recreation control group. The Taijiquan group did not, however, exhibit a significant difference in self-regulatory or self-efficacy behaviors. (Caldwell, Emery, Harrison, & Greeson, 2011)

Travis, et al studied meditation practice and its impact on college students to manage stress. Fifty students were randomly assigned to treatment (meditation practice) or control (delayed treatment). Brain Integration Scale is a composite of three measures: 1) frontal coherence in alpha, beta, and gamma bands 2) alpha/beta absolute power ratios, and 3) timing and magnitude of brain preparatory responses as reflected in the contingent negative variation task difference scores. (In essence, the Brain Integration Scale tests how well students of meditation integrate their meditation experiences with waking, sleeping and dreaming. It reflects the structural and functional connectivity between brain areas.) The Brain Integration Scale scores increased ($F(1,36)=17.5$, pb.0001), and sleepiness decreased ($F(1,36)=10.6$, $p=.001$). The students in the treatment group were less tired as compared to the control. The real test came during high-stress times. Students who practiced meditation appeared to buffer the effects of high stress of finals' week. (Travis et al., 2009)

Elder, et al studied the impact of meditation on a diverse population of minority students. A total of 106 secondary school students (68 meditating and 38 non-meditating students) were studied in both baseline and 4-month post-testing. Results indicated reductions in general psychological distress and anxiety among the students who meditated. Within-group effects on depressive symptoms were observed as well, and the authors recommended that school administrators implement programs of stress reduction because of the association between psychological distress and both adverse school performance and poor physical and mental health outcomes. (Elder et al., 2011)

Nidich, et al, studied 189 at-risk students, and found that regularly practice sessions of meditation at school helped the at-risk students improve academically. Meditating students improved their scores on standardized English tests ($p = .002$) and standardized math tests ($p < .001$) when compared to the control group. A greater percentage of meditating students improved at least one performance level in math and English compared to controls ($p$ values $< .01$). (Nidich et al., 2011)

Kozasa, et al, studied the brain patterns of meditators and non-meditators and found that meditation training improves neurological efficiency, possibly due to an improved ability to sustain attention and increased impulse control. (Kozasa et al., 2012)

Haaga, et al studied the impact of meditation on college students' smoking and use of drugs and alcohol. Although there was no impact on the frequency of smoking and drug use, male college students did decrease their alcohol use after three months ($N = 295$, $F (1, 62) = 7.10$, $P < .05$.). (Haaga et al., 2011)

**Research on Exercise and Performance**

Exercise and its impact on health has been accepted as legitimate for much longer than meditation or relaxation activities. Exercise does not normally connote the idea that cognitive function can be increased in children and young adults, though there is an accepted research conclusion that physical exercise can stave off dementia in the elderly. (Aarsland, Sardahaee, Anderssen, & Ballard, 2010)

Budde, et al, found that increased exercise led to improved cognitive processes (such as attention) after high intensity exercise. They studied forty six college students, having some of them exercise until they reached their maximal heart rate, and some of them rest (the control). They found a significant interaction between physical activity participation level and exercise effect on cognitive performance. The students in the exercise group improved their performance in the cognitive test after the exercise, while the control group students did not improve. (Budde et al., 2012)

DelGiorno, et al, found the opposite. They tested thirty participants exercised for 30 min at maximum (ventilatory threshold, VT) or below maximum (75% of VT). They used as two different tests (card sorting and contingent continuing performance) as measures of executive control. The tests were administered before, during, and immediately after exercise, and 20 min later. The students who exercised below maximum did better than the students who exercised at maximum intensity. They believe the brain needs time to return to normal after intense exercise before being given cognitive decision making tests. (Del Giorno, Hall, O'Leary, Bixby, & Miller, 2010)

Efrat reviewed seven major studies from 1997 to 2009, looking at the impact of physical exercise and school performance. Efrat found that regardless of socioeconomic status or ethnicity, a positive relationship exists between physical activity and academic-related outcomes, and suggested that integrating more physical activity into the school day may be an effective strategy to improve performance. (Efrat, 2011)

John Ratey, a Harvard clinical associate professor of psychiatry, goes a step further. He argues for more physical fitness for students in school today, and calls physical exercise "Miracle Gro" for the brain. (Peterson, 2008)

Sibley, Etnier, and Le Masurier studied college students. The experimental group would do an aerobic exercise for 20 minutes, while the control group did a sedentary activity. The students doing the exercise had improved performance on the cognitive task (Stroop color-word test), but no change in performance on the negative priming task. They felt that exercise may enhance cognitive performance by improving goal-oriented processing in the brain. (Sibley, Etnier, & Le Masurier, 2006)

**Research on Learning Technology**

Since its introduction in the latter part of the century, microcomputer use in schools have been studied. (ACM, 1993; Calingaert, Parker, Gallie, Brooks, & Ferrell, 1969). It was determined early on that learning computers was different than learning typical school subjects such as English, math, or social studies. (AECT, 2004; Editor, 2002) ("Jump start on computer literacy," 1998).

Some researchers have even called for an entirely new theoretical framework in which to study human/system interaction. (Fass, 2006) However, for most people, it is enough to realize that using a computer is a combination of both conceptual knowledge, perceptual knowledge, and kinesthetic ability. (Djajadiningrat, Matthews, & Stienstra, 2007), (Eddins, 2005)

There have been many articles written that purport to help schools determine the best way to teach information technology and its odd-mixture of types of knowledge. (Eddins, 2007; Fundaburk, 2004). There have been articles on the impact of technology in the schools on all subjects. (Wyatt, Saunders, & Zelmer, 2005) (Vogler & Virtue, 2007) (Yildirim, 2000) (Dusick & Yildirim, 2000)

Dunphy and Meyer proposed utilizing multi-media in order to enhance student performance in business courses. They believe that a multimedia approach in a business management course will add a new dimension and enhance learning. (Dunphy & Meyer, 2013)

Dickinson and Dickinson utilized an on-line computer simulation to teach a senior seminar "capstone" course in business administration, and found that the students' performance improved significantly when they added a face-to-face business executive available to coach the students when running the simulation. (Dickinson & Dickinson, 2012)

There have been articles that investigate the brain changes and the motor-neuron connection when using computers. (Shih-Wei, Delgado, & Maloney, 2009; Ugrinowitsch, dos Santos-Naves, Carbinatto, Benda, & Tani, 2011).

Furthermore, there has been much discussion on whether and how computers can be used to test the ability to use them, as well as other kinesthetic activities such as nursing or driving. (Hauer, Holmboe, & Kogan, 2011; Kennedy, Long, & Camins, 2009; Nourbakhsh, 2006; Odhabi, 2007; Steele, 2006; Yaghmaie & Jayasuriya, 2004; Young, 2004)

**Research Integration of Multiple Domains**

It is obvious, both from reading the research and from professional experience as instructors of a hands-on computer course that computer applications must be taught and tested very differently from teaching computer concepts. It is also obvious that a hands-on computer test, given on a computer about computers, is often much more stress-inducing than a typical test (even when that typical test is given on computers), and therefore may be more prone to being influenced by test anxiety. In an attempt to identify a way of improving the performance of students in the computerized exams given in an information technology (IT) course, the researchers conducted this study.

**RESEARCH METHOD**

This is an experimental research study to identify whether or not the prior-to-exam activity has any impact on performance on either concept-based multiple choice tests, or hands-on computer application mastery tests. The course used is required for all Business students, and is typically taken by Freshman or Sophomores as part of their core business courses before choosing a major course of study. The course typically has four exams; two of which are more conceptual (i.e. terms, definitions, theory, categorizations) and two of which are hands-on Office applications (spreadsheet and/or database). It was determined that it would be beneficial to compare meditation and exercise as prior-to-exam activities, and to make that determination based upon the conceptual exam or the hands-on exam.

The null hypotheses:

1. There will be no difference in the student performance on the IT concepts exam based upon the prior-to-exam activity groups when controlling for Grade Point Average.
2. There will be no difference in the student performance on the hands-on computer applications exam based upon the prior-to-exam activity group when controlling for Grade Point Average.
3. There will be no interaction between the type of test, and the prior-to-exam activity when controlling for Grade Point Average.

It would be necessary to control for grade point average as a co-variable in order to avoid that variable mitigating the results.

## Independent Variable

Students were randomly assigned to one of four research groups. Group One was told to sit quietly, close their eyes, breathe deeply, and envision getting an A on the exam, for 5 minutes prior to the test. Group Two was told to exercise vigorously (running up and down stairs, doing jumping jacks, etc.) for 5 minutes prior to the test. Group Three was told to study, either alone or in groups, in the classroom for 5 minutes prior to the test. All three experimental groups were given a written instruction sheet describing the purpose of the study and identifying which group they were in along with a written description of the activity. The group activity was demonstrated by the instructor and the student groups were monitored at random points throughout the period until it was time to come in and take the exam. Group Four was not told anything, was not given any written instructions, and did not do anything differently prior to the test. (In the initial design, the study group was considered the control, but after further discussion and thought, it was determined that it would be better to have an actual control group; one that didn't do anything differently prior to the test. This extended the time invested in the research multiple semesters were needed to have enough students to separate into four different groups, but improved the design of the study.) At the end of all the semesters in which the experiment took place, the exam results were placed into a database and analyzed using SPSS.

## Independent Variable

This analysis was conducted on two different types of tests. One, the IT Concepts exam, was a multiple-choice exam on terminology and concepts typical of that given in an information technology course. The exam itself is given using an on-line exam tool (in this case, using Desire2Learn, the course management system utilized by the university). The other, the Hands-on Computer Application exam was a hands-on assessment of their mastery of computer applications (Microsoft Powerpoint and Excel) in actual use. The students are given a paper sheet of instructions, where they are told where to get the datafiles necessary to complete the exam. They copy the datafiles into their own personal exam folder (set up at the beginning of the semester), and follow the instructions to make changes to the files. When they are finished, they go into the on-line exam tool and answer questions about the files they just completed. Often they are asked to copy and paste formulas or the results of formulas into the answer blank of the on-line exam.

## Data Analysis

The data was reviewed for missing variables. Any records with missing dependent variables (IT concepts or hands-on computer application exam results) were eliminated. In the case of GPA, an independent covariate, the missing variable was replaced with a "C" grade (2.0). Next, the data was checked for outliers, normality, linearity, and homoscedasticity of each of the variables.

The variables initially had outliers, so the data was transformed, replacing those values that exceeded the Mahalanobis chi-square cut-off criteria (16.288 at p>.001 with 3 df) with the minimum value. A manual review of Box-plots showed that all outliers had been eliminated. The data was also reviewed manually for linearity and normality. Skewness and kurtosis were within tolerances (ranging from -.9 to -.09), so the assumption for a normal distribution for each individual dependent variable was met despite the fact that Komogorov-Smirnov calculation was significant. Leven's Test indicated that the assumption of homoscedasticity in each variable was also met (i.e., was not significant). The IT Concepts exam variable had a Levene's result of F=.41, p=.75, and the Hands-on Computer Application exam variable had a Levene's result of F=1.2, p=.31.

After each individual variable had been assessed, the normality, linearity, and homoscedasticity for each group of multivariate data was assessed. All measurements met the assumptions for normality, linearity, and homoscedasticity.

## RESULTS

A multiple analysis of co-variance (MANCOVA) on the dependent variables (IT Concepts exam, and Hands-on Computer Application exam) was conducted based upon the independent factor assigned group (Exercise, Study, Meditation, or Control) controlling for the co-variable Average GPA.

A significant difference was found for the hands-on computer application exam. The Between Subjects Effects showed that there was a significant effect using the 90% confidence interval of the Research Group on the Hands-On Computer Application exam (n= 171, F=2.714, p=.047), but not on the IT Concepts multiple choice exam (n=171, F=1.439, p=.233), as can be seen in Table 1 (Appendix).

The estimated marginal means for the two dependent variables for each of the research groups (exercise, meditation, study, and control) are shown in Table 2 (Appendix). In general, students did better on the hands on computer application exam than they did on the IT concepts exam.

A review of the plots of those means demonstrates the direction of the effect in Table 3 (Appendix). The meditation group clearly did better than any of the other groups. The exercise group performed the most poorly. The study group performed about the same as the control group (thus invalidating the reason for identifying a completely different group to serve as a control, for the study group would have served just as well, though that was not known at the time). Although the same pattern is seen in both the IT Concepts exam and the Hands On Computer Application exam, significance was only reached in the latter. In the IT Concepts exam, even though the control group mean was lower, it was close enough to the meditation group mean that within group variance may have accounted for the difference.

## CONCLUSIONS

It is not surprising that meditation would impact a hands-on computer application exam more than the IT Concepts exam. Since a hands-on exam requires much more logical thought and clear thinking along with integrating kinesthetic activities (involving eye-hand coordination) rather than simply memorizing terms, it seems reasonable that the effect of the prior-to-exam activity would more clearly impact the results. It must be noticed, however, that even though the terminology and concepts exam did not demonstrate a significantly different result, the pattern (the meditation group outperforming all other groups) remained the same. Clearly it is more beneficial to meditate and envision getting an "A" than it is to do jumping jacks or run up and down the stairs prior to a hands-on exam, and probably would be helpful for any exam. Teachers might take note of this and, given enough time, encourage their students to sit quietly, breathe deeply, and think about getting an "A" prior to each exam.

There are limitations to this study. Although the research groups were randomly assigned, the control groups were a factor of semester; there may have been some difference in the semester that the control groups were added that didn't impact the semester when just the research groups were assigned. However, the fact that the study group resulted in a very similar mean as the control group would indicate that there were no meaningful differences due to the semester.

The researchers recommend that these preliminary results should be replicated with a larger group of students, and perhaps with a larger variety of test types. Furthermore, the research design could be improved by extending the time devoted to the prior-to-exam. In this case, the amount of time available for the exam was very limited, and the researchers did not feel it would have been fair to the students to take more time. However, in practice, based upon the comments of the students, the five minutes actually seemed like a very long time (especially to the group assigned to do jumping jacks and run up and down the stairs)!

Further research is needed to determine the parameters for the scope of activities that influence performance. It would be interesting to identify, for example, whether this effect is only seen in computer application exams, or whether other kinesthetic/cognitive exams such as an automobile driving test or a vo-tech exam on plumbing or mechanics would be equally impacted.

The authors conclude that prior-to-exam activity may be a strong influence in exam performance, especially when the exam is testing a combination of kinesthetic and cognitive information such as that needed for hands-on computer application exams, and that meditation may be an effective coping mechanism to mitigate test anxiety and improve exam performance.

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# Appendix

## Table 1 Between-Subjects Effects of Dependent Variable (IT Concepts exam and Hands-on Computer Application exam)

**Tests of Between-Subjects Effects**

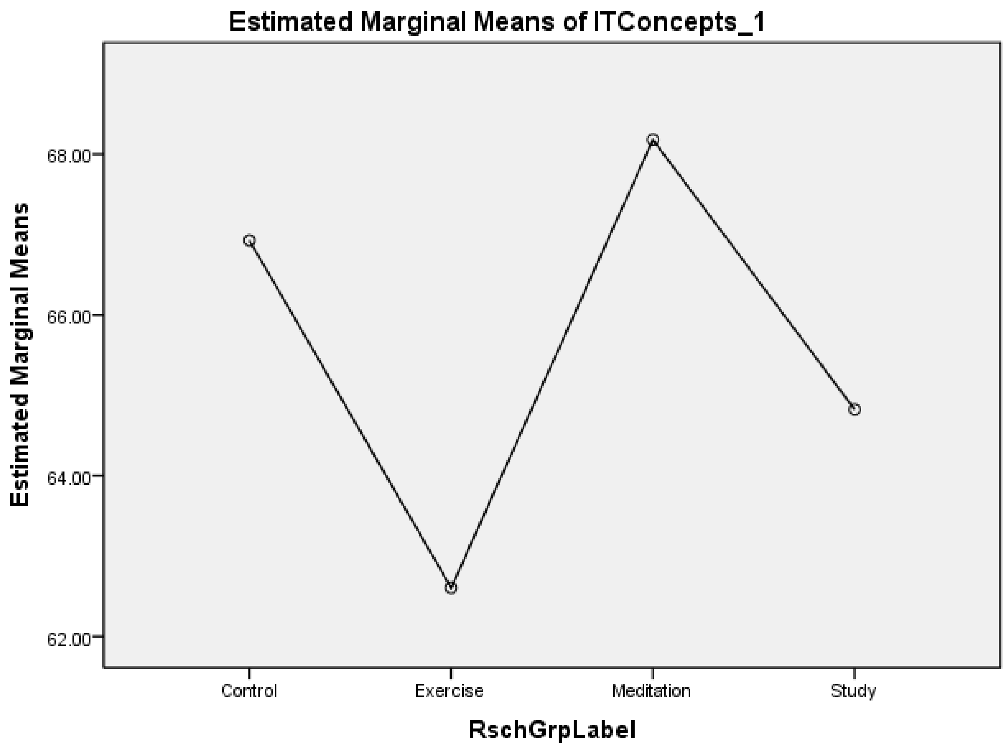
| Source | Dependent Variable | Type III Sum of Squares | df | Mean Square | F | Sig. | Partial Eta Squared |
|---|---|---|---|---|---|---|---|
| Corrected Model | ITConcepts_1 | 1811.546[a] | 4 | 452.887 | 3.130 | .016 | .070 |
| | HandsOnApps_1 | 5464.022[b] | 4 | 1366.006 | 3.026 | .019 | .068 |
| Intercept | ITConcepts_1 | 19498.933 | 1 | 19498.933 | 134.753 | .000 | .448 |
| | HandsOnApps_1 | 24219.453 | 1 | 24219.453 | 53.644 | .000 | .244 |
| AverageGPA_1 | ITConcepts_1 | 1076.087 | 1 | 1076.087 | 7.437 | .007 | .043 |
| | HandsOnApps_1 | 1743.882 | 1 | 1743.882 | 3.863 | .051 | .023 |
| RschGrpLabel | ITConcepts_1 | 624.494 | 3 | 208.165 | 1.439 | .233 | .025 |
| | HandsOnApps_1 | 3676.346 | 3 | 1225.449 | 2.714 | .047 | .047 |
| Error | ITConcepts_1 | 24020.455 | 166 | 144.702 | | | |
| | HandsOnApps_1 | 74946.937 | 166 | 451.488 | | | |
| Total | ITConcepts_1 | 769607.528 | 171 | | | | |
| | HandsOnApps_1 | 1052633.640 | 171 | | | | |
| Corrected Total | ITConcepts_1 | 25832.001 | 170 | | | | |
| | HandsOnApps_1 | 80410.959 | 170 | | | | |

a. R Squared = .070 (Adjusted R Squared = .048)
b. R Squared = .068 (Adjusted R Squared = .045)

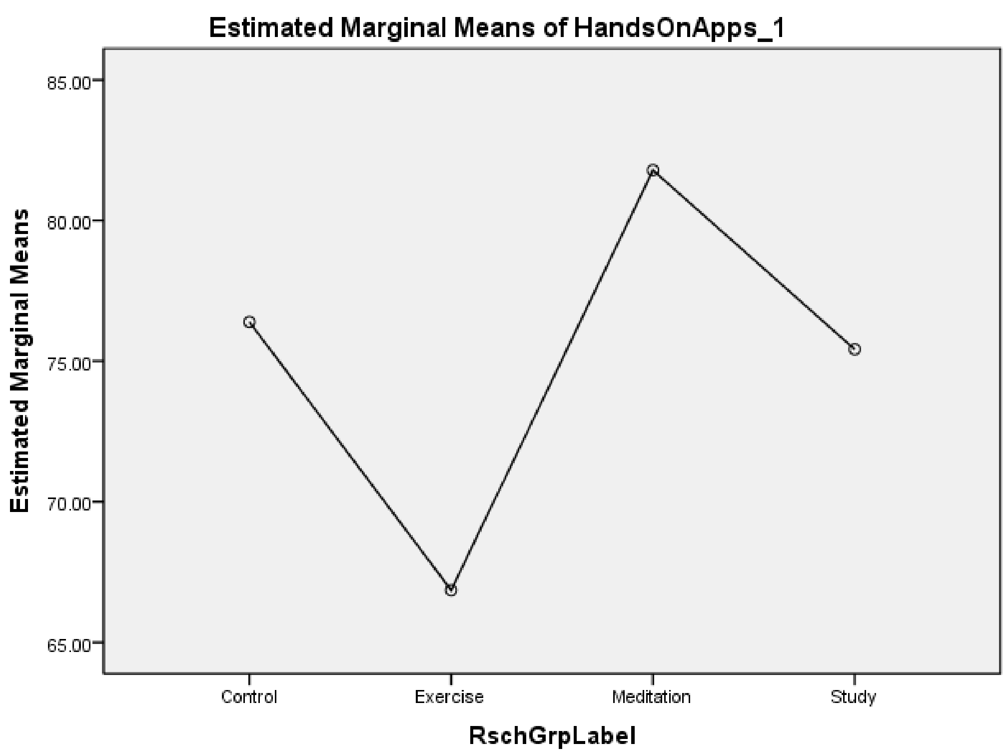
## Table 2. Estimate Marginal Means of Groups

| Dependent Variable | RschGrpLabel | Mean | Std. Error |
|---|---|---|---|
| ITConcepts_1 | Control | 66.927[a] | 1.392 |
| | Exercise | 62.604[a] | 2.129 |
| | Meditation | 68.180[a] | 2.173 |
| | Study | 64.822[a] | 2.129 |
| HandsOnApps_1 | Control | 76.391[a] | 2.459 |
| | Exercise | 66.853[a] | 3.761 |
| | Meditation | 81.786[a] | 3.839 |
| | Study | 75.418[a] | 3.761 |

**Table 3 Plots of Estimated Marginal Means**




Covariates appearing in the model are evaluated at the following values: AverageGPA_1 = 2.8557




Covariates appearing in the model are evaluated at the following values: AverageGPA_1 = 2.8557