

Do Changes in Classroom Ergonomics Affect Learning?

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Abstract- This study identifies use of standing desks and potential outcomes, and aims to increase the body of knowledge of classroom learning strategies using ergonomic modifications. This study seeks to determine the feasibility of whether standing desks “Can Work.” Data was gathered from eighteen students in a masters level occupational therapy program to evaluate if use of standing desks was distracting to learning, led to changes in comfort in various body parts and improved attention, participation, and/or retention of material. Data reflected factors affecting student ability to focus in lectures, results comparing standing to sitting were inconsistent. Standing was not found to be superior to sitting during lecture; however the option to change positions was an important factor for student learning. It was determined that standing desks can work and was feasible in college classrooms, and may direct future studies to improve research outcomes on improved ergonomics for classroom learning.

Index Terms- sit-stand workstations, standing workstations, standing desks, classroom ergonomics, feasibility studies

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I. INTRODUCTION

Students and educators spend significant portions of their day sitting in classrooms. To disseminate content, educators are always looking for ways to improve the attention and focus of their students. Educators accomplish this by employing a variety of teaching methods, but could a simple change in body position/ergonomics be one overlooked method? Over the last several years, standing desks have emerged in workplace settings, so when a student asked if they could stand during lecture, we wondered what effect this might have and if this could be a feasible position option in a college classroom.

Why would you want to stand while you work? “Sitting is the new smoking.¹ The majority of research on the use of standing desks focuses on the workplace, while recent attention also focuses on elementary schools. The concentration of studies is on sedentary behaviors, characterized by sitting or reclining, which have been associated with numerous adverse health effects such as obesity, cardiovascular disease, type 2 diabetes, some cancers, and premature mortality.² Studies have also reported a negative association between sedentary behavior and brain health such as decreased cognitive performance, mental distress, and dementia.³ In non-manual occupations, such as in office workers, sitting time can exceed more than 80% of the workday.⁴

Who else may need to stand? Students spend considerable amounts of time in sedentary positions in classrooms and are subject to the same negative effects as office workers. The average individual (ages six and above) in the United States spends 7.7 hours/day engaged in sedentary behaviors.³ In a large cross-sectional study of school-aged children by Usman, Agha, and Ameen “Eighty-six percent of children reported some type of musculoskeletal symptoms in at least one body region.” The study further reported, “Sixty percent of these teenagers complained of pains in back, neck, or shoulder for which they blamed the furniture.”⁵ Fifty-five percent of all college students fail to meet the recommended physical activity guidelines, and the transition to college has been identified as a critical window for decreased physical activity and increased sedentary behaviors, which have been shown to track into adulthood.³

How feasible and acceptable is it to stand while you learn? In one prospective experimental study in elementary classrooms, the use of sit-stand desks and stool units cost approximately 20% more than standard ones, with no further associated costs or loss of instructional time. In addition to decreasing sedentary behavior, the study found positive effects on behavior and classroom performance. A teacher reported, “When standing, the students were more focused, and I could keep their attention for longer...I have one student with severe ADHD and this really helped him academically.”⁶ In a controlled trial pilot study using standing workstations in an elementary school, both children and school staff supported the use by way of a decrease in sedentary positions. Staff appreciated “flexibility in learning” and students reported “little to no musculoskeletal pain or fatigue.”⁷ Traditional classroom furniture encourages sitting. With new knowledge about the measurable negative impacts of prolonged sitting with school aged children and considering seated instructional time only increases as students move to higher grades, one article suggests not changing classroom environments has public health implications, and society must look at redesigning the classroom environments.⁸ In a cross-sectional study at a large University, 95% of students indicated they would like to stand in class and more than half of students and instructors felt standing would improve their physical health, attention, and restlessness.³ This study further suggested that given the large amount of potential standing time, full

institutional adoption of standing desks in all college classrooms could have a significant and wide reaching impact on the sedentary behaviors of college students.

What are some outcomes of using a standing position? A systematic review of providing standing, stand-biased, and adjustable workstations to office workers showed “Decreased sitting time and increased caloric expenditures, as well as improving posture and decreasing pain.”⁸ It is cautioned that a position of prolonged standing is not recommended and could be more harmful than using a combination of postures.⁹ Alternating between sitting and standing working posture had a positive effect on productivity, tiredness, and restlessness for participants working with a light repetitive task.¹⁰

What about cognition? Implementation of sit-stand or active workstations might lead to changes in cognitive functions such as productivity.⁴ Being physically active is associated with an increase in the volume of brain regions associated with some cognitive functions, cortical activation, improved task switching, selective attention, and working memory, as well as verbal learning and memory after cessation of physical activity.¹¹ In workplace settings, the use of standing stations did not negatively affect job performance.^{2,7,12} The measured performance of a reading task and of almost all cognitive function tests did not significantly improve, nor worsen, while on the dynamic workstations.¹⁰ In classroom settings, one pilot study found that using standing workstations in elementary schools improved behavior in the classroom, which was an additional benefit to using standing workstations beyond decreasing sedentary behavior.¹³ A recent pilot investigation with high school students found, “Continued utilization of the stand-biased desks was largely associated with improved executive function and working memory capabilities.”¹⁴

Given the potential to improve learning outcomes in the classroom by simply modifying ergonomics, this study seeks to explore the use of the standing desk with an understudied population, college students. “Feasibility studies can further prior research that did not have direct knowledge of the specific population and can enable researchers to assess whether or not the ideas and findings can be shaped to be relevant and sustainable.”¹⁵ This study aims to determine, “Can it work?” and to determine if studies can be designed to analyze effects on comfort, attention, and retention of lecture material during lengthy lecture courses. As a proposed design for feasibility studies by researchers Bowen et al. eight focused questions are presented along with outcomes of interest for this study, which are presented in Table 1.15

II. IDENTIFY, RESEARCH AND COLLECT IDEA

Research Design

This experimental feasibility study used a closed cohort of graduate students across two semesters. The study gathered pre and post-test data for within-group comparisons. Feasibility intends to determine the direction for future focused research.

Setting, participants, and recruitment

Upon university Internal Review Board (IRB) approval and consent from faculty for students to use standing desks in their classrooms, 28 participants from an occupational therapy master’s program were invited to participate in the study. Criteria for inclusion were students who were enrolled in lecture courses during a semester at least one and a half hours long. Of the 18 students who consented to participate in the study, five were between 20-25 years of age, seven were between 26-31 years of age, and the other six did not disclose. There was only one possible male participant within this cohort.

Data Collection

The standing workstations were borrowed from another department, who obtained the desks through a previous grant. The desks were a basic height adjustable table top model and were set up on tables in the back of lecture classrooms. Research participants randomly selected lecture courses in which they would use the standing desk. All students and faculty were aware that any student may be a participant in the research, but students assigned themselves a fake name for data collection purposes. Throughout two semesters, students utilized standing desk stations for at least three sessions of a lecture course lasting at least 1 to 1 ½ hours. Students completed a pre and post use questionnaire. Students also completed the same pre and post use questionnaire for three sessions of sitting during 1 to 1 ½ hour lecture courses through the semester for comparison.

Measures

Participating students were administered a Classroom Experience Questionnaire created by the researchers to identify pre-existing issues with attention, body pain, and/or diagnosis of attention deficit disorder (ADD) or attention deficit hyperactivity disorder (ADHD). The questionnaire asked how often students had difficulty with focus during classroom lectures and why; if students experienced discomfort with prolonged sitting and in which areas; and the amount of time in minutes that students could concentrate before noticing discomfort. The pre-test questions asked students about overall level of pain, discomfort, fatigue, and level of personal distraction prior to lecture. The post-test questions asked students about their overall level of ability to attend and focus on lecture, overall level of physical pain or discomfort, amount of material that student felt they retained, and their level of classroom participation. The post-test for the standing desk also asked how long the student was able to stand at the desk station.

Data Analysis

The Classroom Questionnaire is depicted in graphical representation of the summary of responses from all participants. Pre and post-test data was entered into IBM SPSS system (Version 23.0; IBM Corp., Armonk, NY). Independent t-tests were run as well as a two-tailed Pearson correlation based on the dependent variables of discomfort, focus, participation, and retention of material and the independent variables of sitting versus standing to identify if there were any relationships that could yield useful information.

III. WRITE DOWN YOUR STUDIES AND FINDINGS

Results/Findings

Based on feasibility study typology adapted by Tickle-Degnen, findings should include examination of process, resources, management, and scientific basis, which are included in this section and provide answers to the questions from Table 1.16

Process feasibility findings

To answer the question of *acceptability*, out of a class of 28 students, 18 students completed consent forms, agreeing to utilize standing desks across two semesters, and 15 data sets were completed, demonstrating a 54% acceptance. Prior research about perceived benefits of using standing desks by Benzo et al. students and instructors predicated no change or positive changes by using the desks. This study anticipated similar results and found that it depended greatly on how the student felt physically and mentally on any given day to how sitting or standing affected their learning.³ Students utilized standing positions and reported effects of sitting during lectures more than was required for the study. Long after the study, students continue to use standing desks as needed in the classroom. These factors aid in the determination that the incorporation of standing desks is indeed acceptable in a college setting.

Regarding *demand*, while more data was provided than required, fifteen complete data sets were received (pre and post-test data on three times standing and three times sitting). Based on the Classroom Experience Questionnaire, there were several issues reported that impact learning. Twenty-six percent of students indicated that they had a diagnosed or undiagnosed condition of ADD or ADHD. About 35% of students indicated frequent or very frequent difficulty with focusing during a typical lecture session (Figure 1). Several factors interfered with focus including discomfort in sitting (Figures 2 and 3). Within 20 minutes, over 30% of the class indicated they experienced discomfort that affected concentration and by 30 minutes, over 85% of the class indicated discomfort (Figure 4). The article on perceived use of standing desks in classrooms reported 34.5% of students thought that they would stand for an average of 25% of the time during a lecture course.³ Students in this study indicated the average length of time they used the standing desk was 88.9 minutes and the reason for discontinuing use was knee pain, low back pain, or the lecture session ended early.

As far as *implementation*, this study gathered data across two semesters with students determining when they would use the standing desks. One semester was not enough time to gather data due to students not always being able to use the desks when they wanted to. In trying to determine if it was feasible to gain relevant data using pre and post questionnaires, there were more variables than were initially considered and the results were extremely inconsistent. There were wide variations as to when and how long the students used the desks. On some days of standing, a benefit was shown and on other days, students perceived discomfort and attention as being worse. The pre-posttest design was insufficiently set up to accurately measure perceived retention of material.

Resource feasibility findings

Regarding *practicality*, it was decided that five standing desks would be placed on tabletops in the back and sides of the lecture classroom (class of 28) so other student's views of the front of the classroom would not be blocked. While the desks were easily moveable and students told that they could adjust the placement, this was the configuration that remained throughout the study and afterwards. A concern with the study was the limited number of desks available and how students would determine who used a desk at any given time. There were more data sets gathered from students on sitting versus standing. The cost for a tabletop standing desk ranges from \$30-\$500 depending on the desired functionality. University departments would need to determine the amount of expense

they are willing to incur. Consideration was given to homemade standing desks, for which there are many templates available on the Internet. One such model was purchased and constructed out of PVC pipe for less than \$20.

Management feasibility findings

As far as *adaptation*, occupational therapy students in subsequent cohorts as well as students from other departments in the same building have continued to use the standing desks that are still available in several classrooms. Faculty have indicated they would like to try the standing desks in their offices. The desks provide flexible options as they are easy to move.

With *integration*, throughout two semesters, there were no complaints made to the researchers from other faculty or from students indicating that having students stand during lecture courses was distracting from the learning environment.

Scientific assessment feasibility findings

As far as *expansion*, similar to other studies, this data did not reveal any significant improvements in attention, focus, or retention of material. However, gains in these areas were seen as intermittent, and students indicated they would like the option to have alternate positions to accommodate their daily needs. Further studies could measure how often and why a student needs to adjust their position during class instead of a required trial of standing for the duration of a class. Further studies should also provide a measurable way to address cognitive components. Regarding limited efficacy, the Classroom Questionnaire could be distributed to other populations of students to determine if they are also experiencing the effects of ADD or ADHD as well as pain in certain body parts that is negatively affecting their ability to learn during long lecture courses.

Discussion

This feasibility study explores the use of standing desks during long lectures in college classrooms and potential effects on comfort, attention, and retention of material. The study reveals a major problem in that students are experiencing pain and discomfort along with decreases in attention and focus after a very short time while in class. This study indicates the use of standing desks can work in a college classroom. Process results indicate desks are acceptable to students and instructors and are in demand. Implementation of standing desks to gather data on its effects may be best addressed through a qualitative study focused on when and why a student needs to change positions during lecture and a more structured pre and post assessment of physical and cognitive effects of using standing desks. Resource results found practicality was limited to cost constraints, as standing desks can vary widely in cost, however there are homemade options that are available to lower costs. Management results related various adaptations for using the desks; the ideal placement for desks is in the back of classrooms, as they do not obstruct others' views and are not distracting when a student changes positions. With adjustable desks available, students can alternate as needed between different positions. Consistent with other studies, simply standing for an entire lecture was not indicated as an effective solution, rather students must build tolerance for static standing. Adaptations to classroom schedules should be considered, such as breaking up lectures into segments where students get movement or position change breaks.

Developing scientific findings to support the use of standing desks will be a challenge. External factors beyond the researcher's control include variations in how the student feels on any given day, stresses outside the classroom, habits that do not facilitate standing for extended periods of time, injury, and schedule considerations. Other considerations include increased numbers of desks for use and type of standing desk options, and ways to address discomfort factors. While feasibility studies tend to lack external validity and rigorous data analysis, limitations of this feasibility study are more than were originally anticipated and should be accounted for in future studies. The variation in student physical and mental presentation is greater than originally expected and it would be beneficial to track how changes in position in the environment changes cognitive function, as other studies are indicating. A population of convenience with homogenous demographics limits insight in perceptions in other demographics. To get more complete data, the questionnaire should be distributed to other cohorts or student populations in different departments on campus. Measurements to control specific daily changing variables need to be in place and tracking should be improved for higher quality of quantitative data collection. Due to the significant amount of time college students spend in sedentary positions and research indicating how detrimental this can be, it is worth exploring further simple ergonomic changes that can be made to improve physical and cognitive function for the best learning environment possible.

IV. CONCLUSION

Given knowledge that students in learning environments frequently become physically uncomfortable and lose attention quickly in stationary positions, having standing desks available for use in college classrooms can provide one viable option. This feasibility study concludes that it can work rather easily within this environment. Considerations should be given to measuring specific positive effects

that could assist with funding and wider use of alternate positioning equipment in learning environments. The background literature brings forth widespread benefits of movement and ergonomics and studies like this can highlight ways to develop awareness and to establish preventative habits as students move into workplace settings.

Declaration of Interest

This study is unfunded. The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this paper.

V. APPENDIX

Table 1. Feasibility Questions and Outcomes of Interest.

Area of focus	Question	Outcome of Interest
Acceptability [process]	Will the standing desks attract students interested in using them?	Reaction of interest in participation from students inside & outside of the test group
	How could a change in classroom ergonomics influence learning?	Perceived positive and negative effects of standing
Demand [process]	How many students will agree to try the desks?	# of complete sets of data from those using the desks
	Are students uncomfortable or inattentive when sitting during typical lengthy lecture classes, and in need of other options?	Amount of time students remained standing at the desks
Implementation [process]	Can we effectively measure differences in attention, discomfort, participation, and retention of material when sitting versus standing during lectures?	Pre and post test data standing versus sitting during a lecture
	Will students follow through on data collection across 2 semesters using the standing desks 3 times and sitting 3 times?	Number of complete pre and post data sets collected
	Is the period and frequency effective to evaluate the parameters?	
Practicality [resource]	Is the cost of the standing desk too excessive for the benefits?	Cost analysis Space Considerations
	What is the ideal number of standing desks needed in a classroom?	
	What is the optimal classroom design for positioning the desks?	
Adaptation [management]	Where should desks be placed?	Classroom space analysis
	How easy are the desks to use, can they be moved or adjusted to individual students?	Course schedules
	What happens if there are changes in lecture schedules?	Equipment flexibility

	Was this type of desk effective or should other kinds of standing desks be utilized?	
Integration [management]	Will the desks be distracting to professors or students who are not using them?	Feedback from students and faculty
Expansion [scientific]	Will college students experience similar benefits as other settings/populations where standing desks are used?	Comparison to other studies Limitations of study Modifications to data collection
	How should further studies be set up to gather more quantitative and qualitative data? What other information should studies include?	
	Will the pre and post data generate the data needed to make further studies	

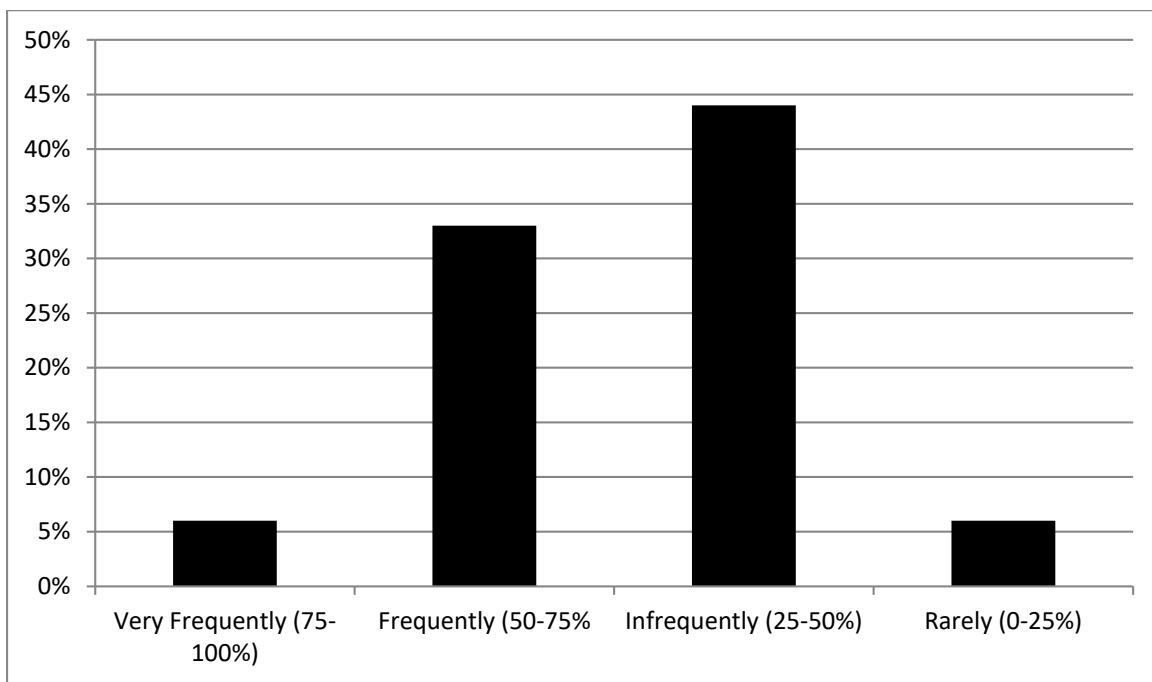


Figure 1. Student reports of difficulty with focus during lectures.

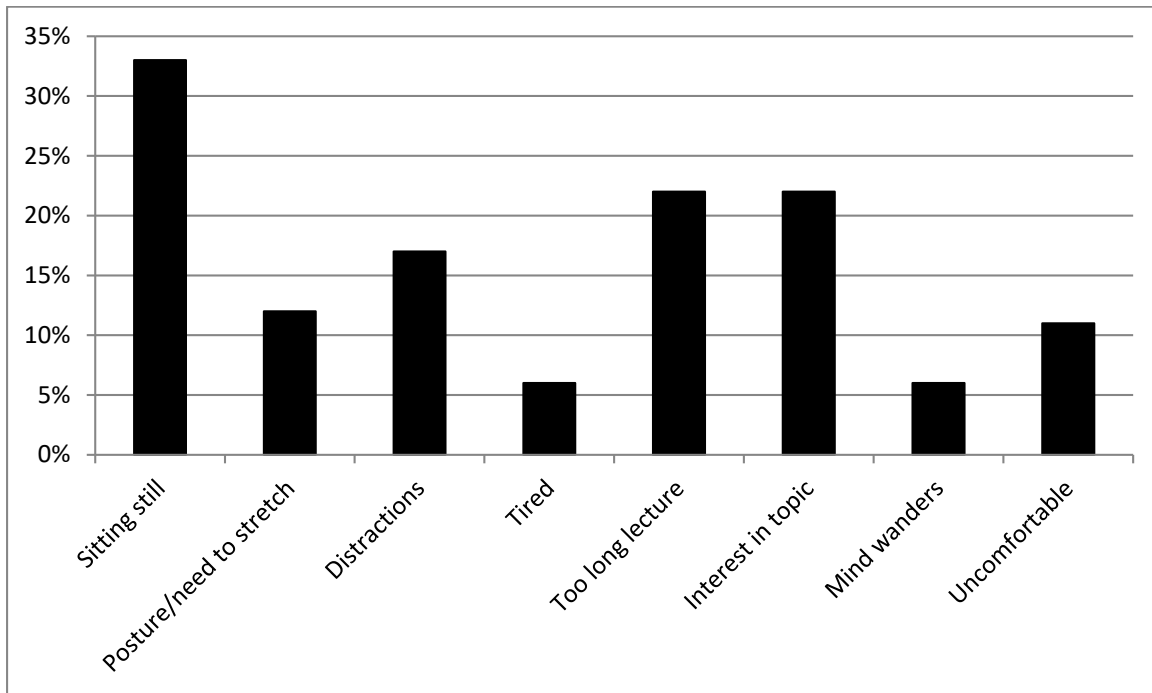


Figure 2. Student reports of factors interfering with attention during lectures.

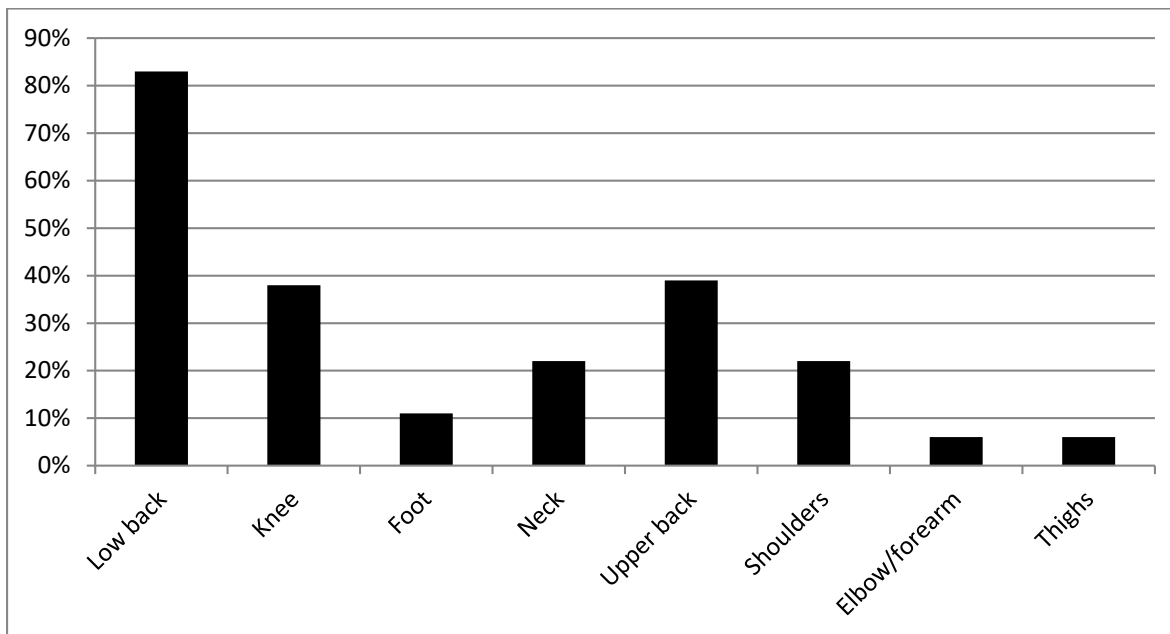


Figure 3. Student reports of areas of body discomfort during lectures.

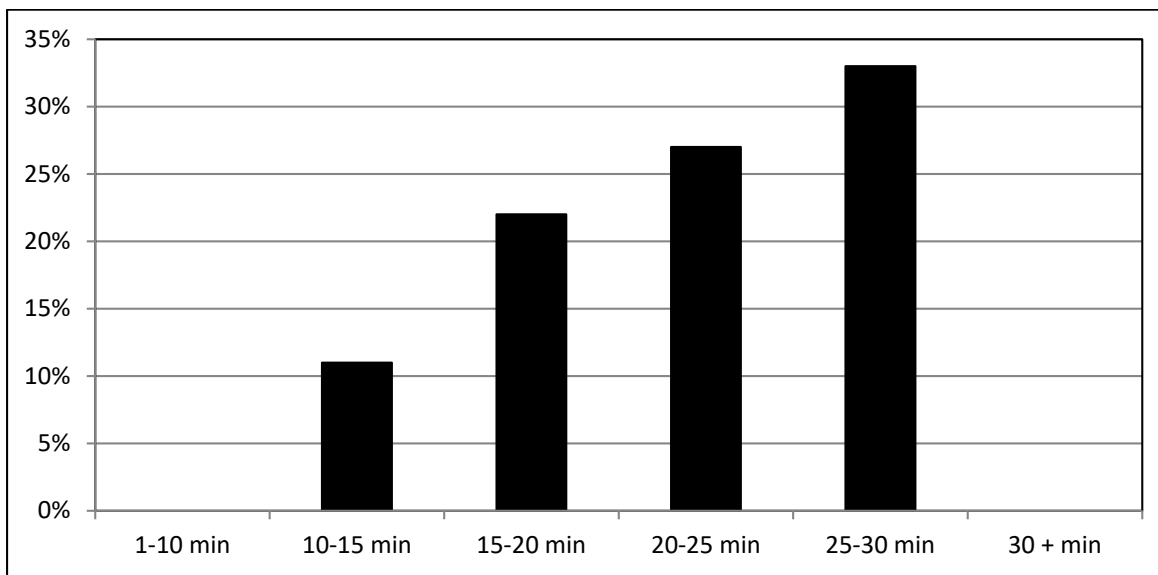


Figure 4. Student reports of amount of time being able to concentrate on a lecture before experiencing discomfort.

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