# How Typography Affects Student Performance in Physics and Astronomy

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## Introduction

A text's perceived difficulty can be affected by typography: the style and appearance of printed data[1]. Typography determines the ease with which a reader can identify individual characters in a text, and the ease with which a reader can recognize words [2]. It can also impact the ease with which a student can understand material, particularly when that student has a reading disability. The British Dyslexia Association (BDA) provides accessibility guidelines for fonts, layouts, and headings, designed so students with reading disabilities can read more comfortably [3]. This leads to the research question: Do typographical choices affect how all physics and astronomy students perceive physics tests and assignments, as well as how they perform on said tests and assignments?

While the 5.3 to 11.8 percentage of the population with diagnosed dyslexia could be accommodated on an individual basis, the nature of dyslexia as a hidden disability means the actual percentage of dyslexic students could be much higher [4]. The range of severity of reading difficulties with dyslexia also means that there is a population of students with no documented learning disabilities who would benefit from more readable tests. If other disabilities that affect reading speed and comprehension are considered, the result is a wide range of students who would benefit from professors following BDA guidelines [5].

The guidelines provided by the BDA correlate closely to guidelines for quality instructional design suggesting that following BDA guidelines could improve exam readability for all. As with many improvements implemented for a disadvantaged population, we anticipate that improving exam readability for those with dyslexia will be beneficial to the entire student population as well.

## Research Questions

1 Do students perceive tests written using BDA guidelines as easier to understand?

2 Do exam questions written using BDA guidelines produce better scores as compared to unmodified questions?

For each question, we seek to answer the following sub-questions:

a Does the level of the course- pre-engineering calculus-based introductory physics, introductory physics for life sciences, or low math physics for non-technical majors, affect the results of the two main research questions?

b If so, how does the level of the course affect the answers to the research questions?

## Proposed Study

We propose a two-stage research project to start in Fall 2017 to answer the two main research questions. The research study will continue until we have obtained enough data to answer the research questions. Each of the stages will occur simultaneously and results will be triangulated at the end of the study. Each question used in both stages of this study, will have the readability determined by the researcher-developed Readability Rubric based on the BDA guidelines, as well as the difficulty assessed by a panel of experts.

**Research Question 1:** Volunteer students will participate in individual clinical interviews to determine if they perceive more readable questions to be less difficult to understand. During the interviews, each student will be provided with 5-8 randomly selected questions that are either high readability or regular readability selected from a pool of equal number of less readable and higher readable questions of varying difficulties. The students will be asked to organize the questions in order of perceived difficulty and explain their reasoning.

**Research Question 2:** We are seeking instructors teaching physics at the introductory level, either Pre-engineering calculus-based introductory physics, Introductory physics for life science course, or low math physics for non-technical majors, that are willing to participate in the study. Each instructor will need to agree to create two versions of multiple different exam questions, one will be either unmodified or with increased readability. These two different versions of each question will need to appear on a different version of the exam. Each exam should contain multiple questions of each version type. Instructors will need to provide copies of the two versions of each problem and as well as the percent of students solving the problems correctly.

**Note:** Each institution/ instructor needs to obtain their university's IRB approval prior to the beginning of the study. Assistance with IRB forms will be provided prior to the beginning of the study.

## Call for Volunteers

**Study 1:** We are seeking a number of volunteers, who would work with us to collect data from their students for the first study. We are primarily seeking volunteers within the Midwest, so we can easily travel to conduct the interviews.

**Study 2:** We are seeking instructors of moderate to large sizes courses throughout the US for each of the three levels of physics we are interested in.

## Guidelines For Physical Media

1 **Paper:**
   a Paper should be opaque.
   b Use matte paper rather than glossy.
   c Avoid digital print processing which tends to leave paper shiny.
   d Avoid white backgrounds, use cream or a soft pastel color.

2 **Font:**
   a Use a plain, evenly spaced sans serif font
      i Arial, Century Gothic, Comic Sans, Tahoma, Trebuchet, or Verdana.
   b Font size should be 12-14 point or larger.
   c Use dark colored text on a light (not white) background.
   d Avoid green and red/pink as these are difficult for color-blind individuals.

3 **Headings and Emphasis:**
   a Use **bold** to emphasize text.
   b Avoid underlining, italics, and all caps.
   c Use larger font size in bold, lower case.
   d Boxes and borders can be used for effective emphasis.

4 **Layout:**
   a Use left-justified with ragged right edge.
   b Avoid narrow columns (as used in newspapers).
   c Lines should not be too long, 60 to70 characters.
   d Avoid cramping material and using long, dense paragraphs: space it out.
   e Line spacing of 1.5 is preferable.
   f Avoid starting a sentence at the end of a line.
   g Use bullet points and numbering rather than continuous prose.

5 **Writing Style:**
   a Use short, simple sentences in a direct style.
   b Give instructions clearly.
   c Avoid long sentences of explanation.
   d Use active rather than passive voice.
   e Avoid double negatives.
   f Be concise.

6 **Increasing accessibility:**
   a When explaining procedures use flow charts, pictograms or graphics help to locate information.
   b To highlight aspects of good practice, use lists of 'do's and 'don'ts' ratherthan continuous text.
   c Avoid abbreviations and jargon if possible or provide a glossary ofabbreviations and jargon.

To Volunteer: http://stemedsolutions.com/projects/readabilitystudy/index.html

To find this poster online: http://stemedsolutions.com/posters/readabilitystudy.pdf

## References

[1] Wikipedia. Typography — wikipedia, the free encyclopedia. https://en.wikipedia.org/w/index.php?title=Typography, 2017. [Online; accessed 07-July-2017].

[2] Wikipedia. Readability — wikipedia, the free encyclopedia. https://en.wikipedia.org/w/index.php?title=Readability, 2017. [Online; accessed 07-July-2017].

[3] British Dyslexia Association. Resources. http://www.bdadyslexia.org.uk/educator/additional-resources-for-educators, 2017. [Online; accessed 07-July-2017].

[4] Slavica K. Katusic, Robert C. Colligan, William J. Barbaresi, Daniel J. Schaid, and Steven J. Jacobsen. Incidence of reading disability in a population-based birth cohort, 1976Ũ1982, rochester, minn. *Mayo Clinic Proceedings*, 76(11):1081Ũ1092, Oct 2001.

[5] British Dyslexia Association. Dyslexia and specific learning difficulties in adults. http://www.bdadyslexia.org.uk/dyslexic/dyslexia-and-specific-learning-difficulties-in-adults, 2017. [Online; accessed 07-July-2017].