# The Doctoral Student Math Problem

Evidence indicating most doctoral students' underdeveloped math skills lead to attrition

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**Abstract**

This paper presents evidence indicating doctoral students' mathematical, logical, and statistical skills are too underdeveloped to understand, validate, and replicate findings in scholarly research or conduct such researches on their own leading to high attrition rates (Bickel, 2021).

The status quo in doctoral education is in dire need of enhanced mathematical, logical, and statistical training—remediation is needed *now*. According to Cronley, Black, and Killian (2019), most doctoral students pursuing PhDs in non-STEM related disciplines fail to complete their dissertations and attrite. While many factors contribute to doctoral attrition, among the most commonly identified reasons students fail are their impoverished mathematical abilities, misuse and misunderstanding of logical reasoning, and lack of computational and analytical skills needed to calculate and evaluate statistics (Cronley et al., 2019). Statistical analysis is one of the core skills required for successful doctoral research Harrington, Petr, Black, Cunningham-Williams, and Bentley (2014).

## Introduction: The Math Problem

### Establishing *Status Quo* Statistical Analysis Illiteracy among Doctoral Students

Presently, a majority of doctoral students lack the mathematical, logical, and statistical skills necessary to complete their degrees and immediate intervention and remediation is both timely and necessary (Cronley et al., 2019; Harrington et al., 2014; & Petr et al., 2015). The importance of statistical, logical, and mathematical literacy is attested to by a study published by Harrington et al. (2014): Among the nine main skills deemed utterly compulsory and essential to doctoral success, mathematics and specifically statistical analysis were identified as two of the most acutely critical. Unfortunately, there is a dearth of mathematical, logical, and statistical literacy among doctoral students: According to a study by Petr et al. (2015) cited in an article by Cronley et al. (2019), *most* doctoral students in non-STEM PhD programs lack sufficient training in statistical analysis.

As a result, Cronley et al. indicates the majority of non-STEM doctoral candidates are poorly educated in statistical analysis (2019). Such students may be completely ignorant of the mathematical and logical significance of the descriptive and inferential statistics which are ubiquitous in modern academic scholarship. The studies by both Cronley et al. (2019) and Petr et al. (2015) emphasize the ***absolute necessity*** for reform, intervention, and training of existing and future doctoral candidates in statistical, logical, and mathematical analysis.

### The Exigent Necessity of Statistical Knowledge & Skills for Doctoral Learners

The admonitory mandate cited above holds true even if doctoral students are pursuing a *qualitative* dissertation or are enrolled in a non-STEM related doctoral program Cronley et al. (2019): The doctoral candidates' abilities to analyze the results, assumptions, and criteria of empirical research they reference will be hobbled; the potential for drawing false conclusions will be accentuated; the ability of statistically-inept students to evaluate the credibility of their sources will be reduced or eliminated; and doctoral attrition rates will continue to rise beyond their current rates exceeding fifty percent. It is an urgent, exigent illiteracy that must be immediately mended or doctoral students lacking these knowledge and skills will have little hope of ever completing a dissertation that requires even a modicum of empirical data collection and analysis (Cronley et al., 2019; Bickel, 2021; Harrington et al., 2014; and Petr et al., 2015).

**Justification for Remediation of Null Hypothesis Testing Skills**

Studies and analyses by Klebel, Reichmann, Polka, McDowell, Penfold, Hindle, and Ross-Hellauer (2020) and the editors of the *Publication Manual of the American Psychological Association* (2019) ramify the centrality and importance of validating and critiquing cited works. According to Bickel (2021), the null hypothesis test is among the *least* understood yet *most* consequential statistical metrics needed to evaluate the credibility of and critique the empirical techniques and findings of any scholarly academic study. Successful doctoral candidates must master their [mis]understandings of the null hypothesis, learn how to perform this test in their own research, and learn how to interpret the results of a null hypothesis test (i.e. learn how to evaluate the test's resulting *P-Value* and make a Boolean decision to either *accept* or *reject* the null hypothesis).

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