# Does Cognitive Style Make a Difference in Learning Statistical Concepts?

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**Abstract**

Many university students who encounter basic statistics for the first time struggle to grasp both the conceptual and practical aspects of the material. Expressions of frustration with the material are frequent and taking the course may be delayed to the end of a student's program because of the perceived difficulty. This is certainly the case at Franklin University in Columbus, Ohio, where students have historically registered numerous complaints regarding statistics education. Successfully completing statistics instruction with a passing grade is a fundamental graduation requirement for business, liberal arts, technology, health, and public administration majors.

A special university taskforce was assembled in March of 2012 to investigate student attrition and poor performance in MATH 215 Statistical Concepts. The taskforce findings confirmed significant student problems in both areas. One of the taskforce members, with a behavioral science background, suggested that a potential cause of the poor performance in statistics courses could be the consequence of a difference in learning styles between the statistics instructors and their students. The fundamental supposition being that instructors prefer to teach in the style in which they prefer to learn, which may be at odds with how different students actually prefer to learn. The instructor-student learning disparity then creates difficulty for the students to comprehend and master the statistics material.

With the support of the Dean of the College of Arts, Sciences and Technology a research study was developed and implemented to test the impact of learning style differences on student performance as measured by their final course grade.

This paper describes the background, testable hypothesis, research design, results, conclusions, domestic and international implications and instructional recommendations that came from the study.

**Keywords:** mathematics education, cognitive styles, statistics instruction

## Introduction

Why is mathematics instruction so difficult for a large number of undergraduate students? The essential challenge of this study was to attempt to understand why, in particular, teaching statistics to undergraduate students can be so fraught with difficulty. Enhancing student

performance in mathematics and science education has been the subject of an increasing number of national and international studies [1, 2]. Some studies have focused on instructional approaches that take students' negative emotional responses, i.e. math anxiety, and learning style differences into account [3, 4]. However, a survey of the literature did not reveal investigations into the instructional impact of a disparity between instructor and student cognitive learning styles.

Pashler [5] states, "There is growing evidence that people hold beliefs about how they learn that are faulty in various ways, which frequently lead people to manage their own learning and teach others in non-optimal ways." Thus arises the idea that instructors may hold personal learning beliefs that are inconsistent with those of the students they teach and that this inconsistency may result in suboptimal student learning. To test the idea that differences in instructor-student learning beliefs, as reflected in learning style differences, negatively affect student learning performance, a working hypothesis was developed. The hypothesis was: *If an instructor's preferred learning style is significantly different from that of his or her student in an introductory statistics course, as measured by Kolb's Learning Style Inventory, then that student's numerical course grade will fall below the overall class grade average.*

## Background & Hypothesis

A Franklin University taskforce was assembled by Dr. Keith Groff, Dean of the College of Arts, Sciences and Technology, in March of 2012 to investigate student attrition and poor performance in MATH 215 Statistical Concepts. The taskforce findings confirmed significant student problems in both of these areas.

As a consequence of the Franklin taskforce results, and consistent with the findings of national and international studies in mathematics instruction, it was proposed that a research project be initiated to investigate the possible link between student math performance and cognitive learning style preferences.

Furthermore, it was a beginning assumption that a potential education disconnect occurs when those that design and deliver mathematics courses are cognitively blind to their own learning style preferences. It was additionally suggested that the educational preparation of many post-secondary mathematics instructors often does not include coursework in instructional methods. This lack of awareness of their own learning styles, in combination with minimal education in instructional methods, may make it problematic for mathematics instructors to explain statistical concepts and computations to students with dissimilar learning preferences. This potential dilemma underscores the importance of math instructors developing the research-informed teaching skills necessary to reach poorly performing students. Such development would entail, for example, cultivating an attitude of empathy toward students struggling with the subject matter, providing a general "big picture" introduction to each new concept including its purpose and usefulness, demonstrating practical applications, and emphasizing through visual illustrations the significant concepts and computational tasks

The study hypothesized that *a significant disparity between instructor and student cognitive learning style preferences will have a detrimental impact on student performance, specifically in MATH 215, Statistical Concepts.*

## Method

The framework for the study was an evidence-based approach to the understanding of individual cognitive style differences and their relationship to post-secondary mathematics education. Knisley's [6] four-stage model of mathematical learning, based on Kolb's learning styles, provided the theoretical underpinning for the study. MATH 215, Statistical Concepts was chosen as the focal course because, as mentioned above, the course had a disproportionate number of poorly performing students, and had been the focus of much management and faculty attention. Due to these factors, and because it is a general education graduation requirement for students in both math-based and non-math-based majors, it was anticipated that the study would include students with a variety of learning style preferences.

According to the Franklin University 2012 – 2013 Academic Bulletin, MATH 215 "…introduces the student to statistics with business applications…" The course covers "…measures of central tendency; measures of dispersion; graphical displays of data; linear regression; basic probability concepts; binomial and normal probability distributions; confidence intervals; and hypothesis testing."

The Learning Styles Inventory (LSI) was selected as the instrument to be used to identify instructor and student learning style preferences. The LSI was chosen because of its wide acceptance and use as a measure of style as well as its reputation as a respected, reliable, and valid measure of learning styles. Kolb [7] has reported evidence related to internal and test-retest reliability, and internal and external validity.

The LSI has undergone five revisions over the past 40 years. One of the study authors has significant prior exposure to and experience in multiple organizations with the instrument. He had also previously worked with the developer of the instrument, Dr. David Kolb, on a multi-year organization development project. Additionally, this author used the LSI for many years, with good success, as part of a developmental assessment battery in an MBA program. Another factor in selection was Dr. Kolb's credibility with Franklin University. His scholarly research and writing on learning had previously earned him an honorary doctorate awarded by the university's president in the middle 1990s.

A further reason for selecting the LSI is that it provides a relatively simple, easy to comprehend, visual model for differentiating four distinct learning styles: diverging, assimilating, converging and accommodating. Thus, reported results are easily interpreted and analyzed for research purposes.

Descriptions of these learning styles were provided in an article by Alice and David Kolb [8] covering technical specifications of the LSI 3.1 that was used in the study. The style descriptions are:

> People with a Diverging learning style have broad cultural interests and like to gather information. They are interested in people, tend to be imaginative and emotional, have broad cultural interests, and tend to specialize in the arts. In formal learning situations, people with the Diverging style prefer to work in groups, listening with an open mind to different points of view and receiving personalized feedback.
>
> Individuals with an Assimilating style are less focused on people and more interested in ideas and abstract concepts. Generally, people with this style find it more important that a theory have logical soundness than practical value. The Assimilating learning style is important for effectiveness in information and science careers. In formal learning

> situations, people with this style prefer readings, lectures, exploring analytical models, and having time to think things through.
>
> Individuals with a Converging learning style prefer to deal with technical tasks and problems rather than with social issues and interpersonal issues. These learning skills are important for effectiveness in specialist and technology careers. In formal learning situations, people with this style prefer to experiment with new ideas, simulations, laboratory assignments, and practical applications.
>
> People with [the accommodating] learning style have the ability to learn from primarily "hands-on" experience. In solving problems, individuals with an Accommodating learning style rely more heavily on people for information than on their own technical analysis. This learning style is important for effectiveness in action-oriented careers such as marketing or sales. In formal learning situations, people with the Accommodating learning style prefer to work with others to get assignments done, to set goals, to do field work, and to test out different approaches to completing a project.

The following procedures were employed to facilitate data collection.

- Arrangements were made with the HayGroup, publisher of the LSI, for online administration, automated scoring and results-capturing.
- MATH 215 instructors and students were sent an email invitation explaining the purpose of the study, and instructions for completing the LSI online during week 14 of the 15 week course. This procedure was followed for each of the three trimesters during 2013. Students' response rate was approximately 30%.
- The data were organized for analysis by grouping students with their respective instructors, including students' LSI learning style mode, gender and final course letter grade. Then, results were analyzed by comparing student grades to the degree of discrepancy between the instructors' and their students' LSI results as a means of testing the hypothesis. Students' names were converted to a randomly generated code to protect their anonymity.

## Analysis and Results

After data collection, students' grades and learning style characteristics, as well as instructors' learning styles, were entered into the SPSS 22.0 (Statistical Program for Social Sciences) software. Data analysis consisted of four major steps: first, a descriptive analysis was used to provide analytical profiles and patterns; second, an independent sample t-test was used to measure whether the instructor's learning style matched the student's learning style as measured by the Learning Style Inventory (LSI) and if instructor/student learning style impacted the student's performance as measured by his/her grade; third, analysis of variance (ANOVA) was used to examine differences among four learning style groups; lastly, the impact of each learning mode (a four-stage cycle of learning) on student performance was explored.

**Descriptive Analysis**

This study investigated whether the differences between instructor and student learning styles account for students' performance disparity in MATH 215. The research design included two major factors: four learning-style types (Diverger, Assimilator, Converger and Accommodator) and two matching conditions (whether instructor's learning style matches student's learning style or not). Additionally, a learning style is a combination of preferences for how we believe we can learn best. There are four modes of preferences – Concrete Experience (CE, learning from feeling), Reflective Observation (RO, learning by watching and listening), Abstract Conceptualization (AC, learning by thinking), and Active Experimentation (AE, learning by doing). A total of 161 college students, including 114 females and 47 males, from 8 math classes participated in the study. Among these 8 classes, we have 1 Diverger instructor, 3 Assimilator instructors, and 4 Converger instructors. No Accommodator style instructor was identified in this study. The student population was distributed fairly evenly among the four learning styles. Table 1 provides a snapshot of the student learning style distribution that was employed for this study.

**Table 1.** Students' Learning Style Distribution.

| | Frequency | Percent |
|---|---|---|
| **ASSIMILATOR (ASM)** | 43 | 26.7% |
| **CONVERGER (CON)** | 41 | 25.5% |
| **ACCOMMODATOR (ACM)** | 40 | 24.8% |
| **DIVERGER (DIV)** | 37 | 23.0% |
| **Total** | 161 | 100% |

Gender differences were also considered and explored as shown in Figure 1. In this research study, there were more Diverger female students than Diverger male students (27% vs 10%), and fewer Converger female students than Converger male students (23% vs 32%). If the

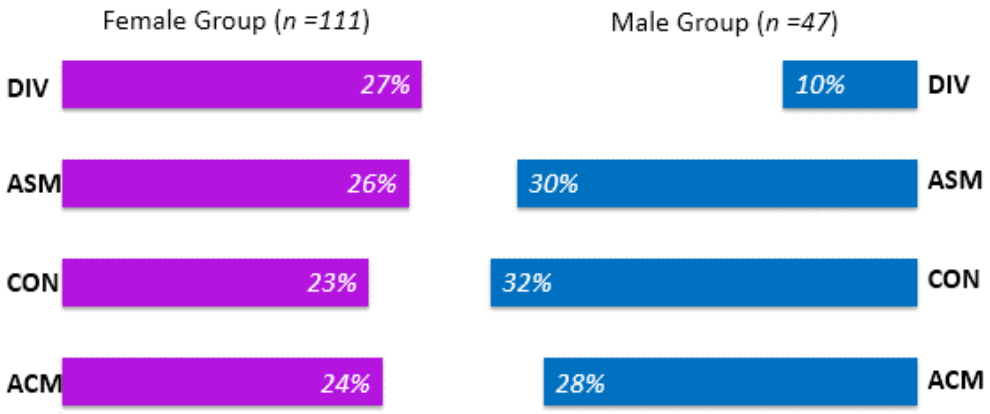



**Figure 1.** Learning Style Distribution by Gender

selected sample is representative of the population, the study supports the notion that female students are more likely to prefer a more social, personalized approach to learning, while male students are more likely to prefer learning by using logic and ideas.

Figure 2 provides a snapshot of the grade distribution for our research participants. There were three outliers for analysis purposes. Two students withdrew from the class and one student did not earn a grade. The means and standard deviations for the grades of each class were calculated as well. Table 2 presents the descriptive statistics for each class. Means and standard deviations for class 1, 2, and 7 have a similar shape. Students from class 3 and class 6 differ in their grades, and the difference is significant, t(38)=-4.09, p=.00.

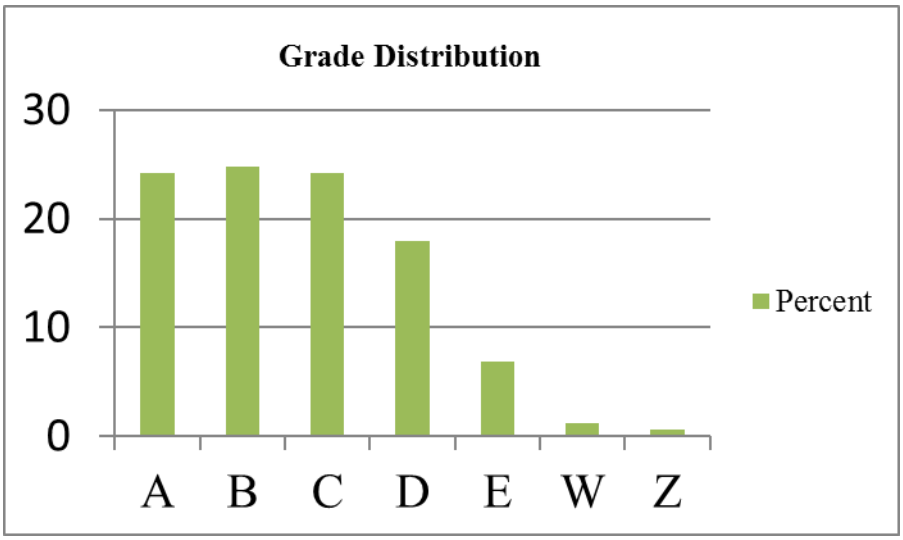



**Figure 2.** Grade Distribution in Percentage *Note: E is a failing grade

**Table 2.** Descriptive Statistics on Means and Standard Deviations for each class

| Classes | Grade | | n |
|---|---|---|---|
| | Mean | SD | |
| 1* | 2.68 | 1.36 | 34 |
| 2* | 2.77 | 1.36 | 13 |
| 3 | 1.85 | 1.13 | 27 |
| 4 | 2.13 | .92 | 15 |
| 5 | 2.00 | 1.07 | 8 |
| 6 | 3.31 | .85 | 13 |
| 7* | 2.49 | 1.17 | 39 |
| 8 | 2.00 | 1.41 | 9 |
| Total | 2.42 | 1.24 | 158 |

Grade distribution by gender (Table 3) was also examined. There is no evidence that indicates male and female students perform differently as measured by grade, t(156) = -.99 p = .32.

**Table 3.** Descriptive Statistics on Means and Standard Deviations by Gender for each class

| Gender | Grade | | n |
|---|---|---|---|
| | Mean | SD | |
| F | 2.36 | 1.24 | 111 |
| M | 2.57 | 1.23 | 47 |
| Total | 2.42 | 1.24 | 158 |

**Main Effect Examination**

In order to test the hypothesis, the sample was coded into two groups: a matched group (student's learning style is same as their instructor's) and a mismatched group (the student and his/her instructor have a different learning style). Forty student styles matched those of their instructors' and 118 students had learning styles different from their instructors. Descriptive statistics for both groups are listed in Table 4. An independent-samples t-test was conducted to test that the mean grade score of the matched group is statistically different from that of the mismatched group. There was insufficient evidence that MATH 215 student performance differed significantly among the two conditions; whether student learning styles matched their instructors or not, t(156)=.448, p=.65. In order to reduce between-group variance, within the studied population, students were selected from statistics classes 1, 2, and 7, and the independent-sample t-test was run again. The results remained the same. There was no evidence that indicated the selected groups differed in terms of average grades, t(64)=-.66, p=.51.

**Table 4.** Descriptive statistics for Learning Style Match and Mismatch groups

| Group | Grade | | N |
|---|---|---|---|
| | Mean | SD | |
| Match | 2.50 | 1.26 | 40 |
| Mismatch | 2.40 | 1.23 | 118 |

Further analysis was conducted to investigate whether the degree of learning style difference mattered. If the instructor's learning style was adjacent to the student's learning style (e.g. Diverger and Assimilator, Assimilator and Converger, etc.), it was coded as a 1-degree difference. If the instructor's learning style is opposite to the student's style (e.g. Diverger and Converger, Assimilator and Accommodator), it was coded as a 2-degree difference. Using this coding there were 77, 1-degree different and 41, 2-degree different students (Table 5). No significant differences were found among any of the three degree conditions, F(2, 155 )=.59. The p value for this statistic is .56. Based on this result, the conclusions were that (a) there is insufficient evidence to reject the hypothesis and (b) that the different degree groups do differ, and (c) the three group centroids are identical.

**Table 5.** Descriptive statistics for Three Degree Groups.

| Group | Grade | | n |
|---|---|---|---|
| | Mean | SD | |
| **Match** | 2.50 | 1.26 | 40 |
| **1-degree difference** | 2.48 | 1.26 | 77 |
| **2-degree difference** | 2.24 | 1.18 | 41 |

An independent-samples t-test was conducted to evaluate the hypothesis that whether participants were taught by the same or a different gender instructor would have an impact on student performance. The t-test was not significant, t(156)=-1.07, p=.28. Therefore, there was no evidence indicating whether instructor and student gender match would or not would have had an impact on students' performance. This collateral evidence (Table 6) failed to support the main hypothesis in this study that when the instructor's learning style is significantly different from the student's learning style, as measured by the Learning Style Inventory (LSI), students' performance would be negatively affected.

**Table 6.** Descriptive statistics for Gender Match and Mismatch groups

| Group | Grade | | n |
|---|---|---|---|
| | Mean | SD | |
| **Match** | 2.34 | 1.21 | 97 |
| **Mismatch** | 2.55 | 1.28 | 61 |

A third analysis was designed to determine if students with different learning styles may perform differently in the math classroom. Descriptive statistics for the four Kolb learning style groups are listed in Table 7. The results of the ANOVA analysis for the hypothesis that the four learning style groups would perform equally well was statistically significant, F(3, 154)=4.16, p=.007. This result indicated that the four groups differed as measured by their average grades. Group means are 2.83, 2.58, 2.33, and 1.89 respectively. Convergers are the highest performers, and Divergers the lowest performers in learning statistical subject areas. A Post Hoc test between Convergers and Divergers was statistically significant, a nearly one letter grade difference, and the mean difference was significant at the .05 level. On average, students who were Diverger style learners were more likely to have a lower letter grade than Converger style learners.

## Impact of Learning Modes

The final analysis was designed to understand how the learning modes impact students' performance. For each learning mode, students were re-coded into two groups: a high preference group (scale scores above 50%) and a low preference group (scale scores below 50%). Table 8 displays high- and low-preference students' performance categorized by four learning modes, Concrete Experience (CE), Reflective Observation (RO), Abstract Conceptualization (AC), and Active Experimentation (AE). A close examination of each learning mode suggested that the impact of different learning modes varied. Students preferring highly concrete experience (learning from feeling) tended to have a lower performance, and it is statistically significant, t(156)=-4.02, p=.00. Students preferring the highly active form (learning by doing)

**Table 7**. Descriptive Statistics on Means and Standard Deviations for Four Learning style Groups

| Mode | Performance | | n |
|---|---|---|---|
| | M | SD | |
| **CONVERGER** | 2.83 | 1.11 | 40 |
| **ASSIMILATOR** | 2.58 | 1.28 | 43 |
| **ACCOMMODATOR** | 2.33 | 1.16 | 40 |
| **DIVERGER** | 1.89 | 1.25 | 35 |
| **Total** | 2.42 | 1.24 | 158 |

have a higher performance, and it is significant as well, t(156)=2.15, p=.03. Students' performance appeared to be statistically sensitive on the concrete experience (CE) and active experimentation (AE) dimensions, but not sensitive on other two dimensions. Figure 3 shows student performance for each learning mode.

**Table 8.** Descriptive Statistics of Four Learning Modes

| Dimension | High | | | Low | | |
|---|---|---|---|---|---|---|
| | M | SD | n | M | SD | n |
| **CE** | 1.88 | 1.22 | 52 | 2.69 | 1.17 | 106 |
| **RO** | 2.34 | 1.26 | 105 | 2.58 | 1.18 | 53 |
| **AC** | 2.62 | 1.26 | 63 | 2.29 | 1.21 | 95 |
| **AE** | 2.59 | 1.21 | 99 | 2.15 | 1.24 | 59 |

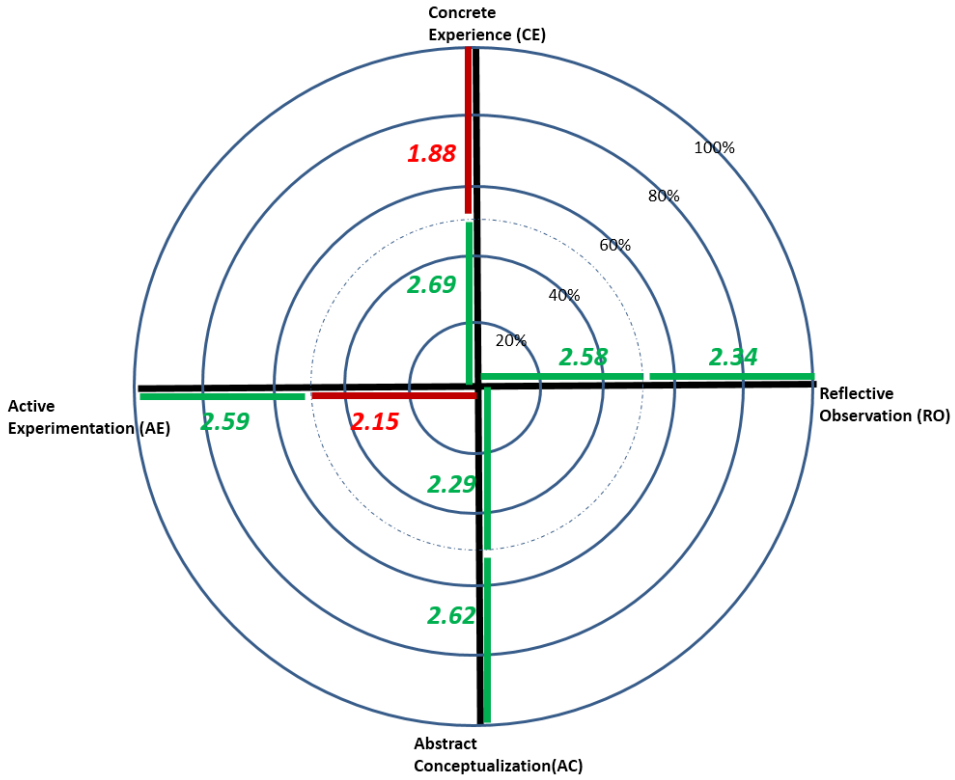
To summarize, there is insufficient evidence that MATH 215 students' performance differs significantly whether (or to what degree) their learning style matches their instructor's or not, t(156)=.448, p=.65. However, the data did suggest that different learning style groups perform differently, and especially, that there is a significant difference between the Converger group and the Diverger group. Students' performance (in MATH 215) does appear to be sensitive on the Concrete Experience (CE) and Active Experimentation (AE) dimensions. This sensitivity may also suggest further attention is needed to a particular learning mode preference group of students. The study results also found the Diverger style to be more frequent among the sample of female students and the Converger style more frequent among the male students.

## Conclusions

Sternberg [9] has reported that studies related to cognitive style, of which Learning Styles is an example, are often contentious, with opposing results attempting to show the viability of the construct or to support the idea that styles do not exist. For this particular study the evidence does not support the entering hypothesis that student grade performance in the selected undergraduate statistics course is related to significant differences between student and instructor

learning styles as measured by the Learning Styles Inventory. The research findings do, however, indicate that student grade performance is statistically sensitive on the Concrete Experience and Active Experimentation dimensions of the LSI.

**Figure 3.** Graphic Presentation of Student Performance by Learning Mode




The study shows that students with the Active Experimentation preference appear to be significantly better grade performers than their classmates with the other three major preferences. The study data also suggests that students with two comparatively different learning style modes (i.e. Converger and Diverger) perform very differently as measured by course grades, although these conclusions may have been constrained by the non-random selection of participants and the size of the sample utilized.

Additionally, the study results may be confounded by students with math anxiety or Dyscalculia (a range of learning disabilities related to mathematics). Betz [10] previously studied the frequency and distribution of math anxiety among college students. Rice and others [11] have implicated impaired brain functioning as a possible source of Dyscalculia. Howard [12] observes that in cases of Dyscalculia learners appear to benefit from the use of multiple teaching modalities that employ touch, sound, smell, and sight in the learning experience.

## International and Managerial Implications

Possible implications for math instruction in statistics:

- Use the LSI to:

1. Help identify the characteristics of divergent thinkers and how they might best learn and benefit from statistics instruction.
2. Raise the awareness of mathematics instructors as to the impact on their students of learning style preferences.

- Identify realistic applications that:
  1. Show how knowledge of statistics can be of benefit to individuals and groups
  2. Create a real-life context and practical examples for presentation of the statistics material.

A potentially useful avenue for further exploration of the impact of instructor thinking styles on student learning performance arises from research on brain function. For example, recent findings in neuroscience [13, 14, 15] suggest that cognitive or thinking preferences rooted in brain organization, impact the ease and proficiency with which learning occurs. Benzinger [16] also reports that, based on brain use of glucose studies, learning consistent with thinking preference may use only $1/100^{th}$ of the energy required in comparison with non-preferred styles.

Thus, presenting math material in a form consistent with a student's preferred learning style may be both more efficient and less mentally fatiguing. Boyatizis and Mainemelis [17] and Smith [18] have researched learning style and teaching applications in the classroom and made recommendations for their use. Further elaboration of the work of Zanakis and Valenzi [19], who previously studied student anxiety specifically related to business statistics, might also be a fruitful area for additional enquiry. Additionally, Knisley [20] has proposed a multi-stage model for mathematical learning to address some of the concept and style issues in teaching numerically-based subject matter.

Internationally, there are potential implications for the instruction of managers in statistics. How might the efficient and effective learning of statistics be influenced by cognitive and cultural factors? In a recent review of the cognitive style literature Kozhevnikov, Evans and Kosslyn [21] aver that, "Another growing trend in the educational literature focuses on examining the relations between learning styles and culture-in particular, country of origin." Thus, further, more extensive, research studies with larger sample sizes, exploring cultural differences in learning statistical concepts may be warranted. This research may be particularly beneficial, as non-domestic students comprise a growing international population within universities based both inside and outside the United States.

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English Abstarct

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**Abstract**

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French Abstract*

Does Cognitive Style Make a Difference in Learning Statistical Concepts?

# Est-ce que les styles cognitifs créent une différence dans l'apprentissage des concepts statistiques?

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**Résumé**

De nombreux étudiants qui rencontrent des statistiques élémentaires pour la première fois, ont du mal à saisir à la fois les aspects théoriques et pratiques. Les expressions de frustration avec la matière sont fréquentes et le suivi des cours peut être retardé jusqu'à la fin du programme d'études d'un étudiant en raison de la difficulté perçue de la matière. Cela est le cas à l'Université Franklin à Columbus, dans l'Ohio, où les étudiants enregistrent historiquement de nombreuses plaintes concernant les statistiques. Réussir les cours de statistiques est une exigence pour l'obtention des diplômes de management, des arts libéraux, de la technologie, de la santé, et pour les majeurs en administration publique.

Un groupe de travail a été réuni en mars 2012 à l'Université pour enquêter sur les mauvaises performances des étudiants en mathématiques et statistiques. Les conclusions du groupe de travail confirment les problèmes des étudiants dans les deux domaines. L'un des membres du groupe de travail, ayant une formation scientifique en sciences du comportement, a suggéré qu'une cause potentielle de la mauvaise performance dans les cours de statistique pourrait être la conséquence d'une différence de styles d'apprentissage de la statistique entre les instructeurs et leurs élèves. L'hypothèse fondamentale est que les instructeurs préfèrent enseigner dans le style dans lequel ils préfèrent apprendre, qui peut être en désaccord avec la façon dont les étudiants préfèrent apprendre. La disparité dans les méthodes d'apprentissage entre instructeurs et étudiants crée alors des difficultés pour les étudiants à comprendre et à maîtriser les cours de statistiques. Avec le soutien du Doyen du Collège des Arts, des Sciences et de la Technologie, une étude a été développée et mise en œuvre pour tester l'impact des différences de style d'apprentissage sur la performance des élèves, telle que mesurée par leur note finale du cours. Ce document décrit le contexte, les hypothèses, la conception de la recherche, les résultats, les conclusions, les implications nationales et internationales et des recommandations pédagogique.

**Mots-clés:** Enseignement des mathématiques, Styles cognitifs, Enseignement des statistiques

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German Abstract*

Does Cognitive Style Make a Difference in Learning Statistical Concepts?

# Macht ein kognitiver Stil einen Unterschied beim Lernen statistischer Konzepte?

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**Zusammenfassung**

Viele Universitätsstudenten, die zum ersten Mal auf grundlegende Statistiken treffen, bemühen sich sowohl die begrifflichen als auch die praktischen Aspekte des Materials zu verstehen. Ausdrücke der Frustration mit dem Material sind häufig und der Kurs kann bis zum Ende des Studentenprogrammes aufgrund von wahrgenommenen Schwierigkeiten verzögert werden. Das ist sicher der Fall an der Franklin Universität in Columbus, Ohio, wo die Studenten in der Vergangenheit zahlreiche Beschwerden bezüglich der Ausbildung in Statistik eingereicht haben. Der erfolgreich bestandene Statistikunterricht ist eine wesentliche Voraussetzung für die Graduierung für Wirtschaft, Geisteswissenschaften, Technologie, Gesundheit und öffentliche Verwaltung.Eine spezielle universitäre Taskforce hat sich im März 2012 versammelt, um die Studentenabnahme und die schlechte Leistung in MATH 215 statistische Konzepte zu untersuchen. Die Taskforce Ergebnisse haben bedeutende Probleme der Studenten in beiden Bereichen bestätigt. Einer der Taskforce Mitglieder mit einem Verhaltenswissenschaftshintergrund hat vorgeschlagen, dass ein möglicher Grund für die schlechte Leistung in den Statistikkursen die Konsequenz eines Unterschiedes zwischen den Lernstilen der Statistiklehren und deren Studenten sein könnte. Die grundsätzliche Annahme ist, dass Lehrer es vorziehen in dem Stil zu unterrichten in welchem sie es vorziehen zu lernen, der jedoch nicht mit dem präferierten Lernstil der verschiedenen Studenten übereinstimmen könnte. Der Lehrer-Student Lernunterschied schafft Schwierigkeiten für die Studenten, um das Statistikmaterial zu verstehen und zu meistern. Mit der Unterstützung des Dekans der Universität der Künste, Wissenschaften und Technologie wurde eine Forschungsstudie entwickelt und durchgeführt, um den Einfluss der Lernstilunterschiede auf die Studentenleistung, die durch die Abschlusskursnote gemessen wird, zu prüfen. Dieses Papier beschreibt den Hintergrund, die prüfbaren Hypothesen, das Forschungsdesign, die Ergebnisse, die nationalen und internationalen Auswirkungen und die Unterrichtsempfehlungen, die sich aus der Studie ergeben.

**Schlüsselwörter:** Mathematikausbildung; kognitive Stile; Statistikunterricht.

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Spanish Abstract*
Does Cognitive Style Make a Difference in Learning Statistical Concepts?

# ¿Produce el Estilo Cognitivo una Diferencia de Aprendizaje de los Conceptos Estadísticos?

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**Abstract**

Muchos estudiantes universitarios que se encuentran con la asignatura de estadística básica por primera vez deben pelearse para comprender tanto los aspectos conceptuales como los prácticos de la materia. Las expresiones de frustración con la asignatura son frecuentes y aprobar esta materia puede retrasarse hasta el final del programa con demasiada frecuencia. Este es ciertamente el caso de la Universidad de Franklin en Columbus, Ohio, donde los estudiantes históricamente han registrado numerosas quejas en relación con la educación de la asignatura de estadística. Completar con éxito la instrucción estadística con una calificación de aprobado es un requisito fundamental para la graduación en negocios, artes liberales, tecnología, salud, y gestión de la administración pública.En Marzo de 2012 se montó un equipo de trabajo especial en la universidad para investigar la deserción escolar y bajo rendimiento en Matemáticas 215 Conceptos Estadísticos. Los hallazgos de este equipo especial confirmaron problemas significativos de los estudiantes en ambas áreas. Uno de los miembros del equipo especial, con una formación en ciencias del comportamiento, sugirió que una posible causa de los malos resultados en los cursos de estadística podría ser la consecuencia de una diferencia de estilos entre los instructores de estadística y sus estudiantes al aprender. El supuesto fundamental es que los instructores prefieren enseñar con el estilo con el que ellos prefieren aprender, lo que puede estar en desacuerdo con la forma en la que los estudiantes desean aprender. La disparidad de aprendizaje instructor-alumno crea dificultad para los estudiantes para comprender y dominar el material de estadística.Con el apoyo del Decano de la Facultad de Artes, Ciencias y Tecnología se ha desarrollado e implementado un estudio de investigación para probar el impacto de las diferencias de estilo de aprendizaje en el desempeño del estudiante, medido por su calificación final del curso.Este documento describe los antecedentes, hipótesis comprobables, diseño de la investigación, resultados, conclusiones, implicaciones nacionales e internacionales y las recomendaciones de cómo enseñar que surgieron del estudio.

**Kewords:** Eduación en Matemáticas, estilos congintivos, enseñanza en estadística

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Arabic Abstract*

Does Cognitive Style Make a Difference in Learning Statistical Concepts?

# هل يحدث النمط الإدراكي فرقا في تعليم المفاهيم الإحصائية؟

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## ملخص

الكثير من طلاب الجامعات خاصة الذين يدرسوا اساسيات الاحصاء لأول مرة يعانوا من فهم الجانبين العملي و النظري للمادة . العديد يعبرون عن احباطهم و يقومون بتأخير دراسة المادة الى نهاية مسارهم الجامعي و ذلك لصعوبة المادة بالنسبة لهم .
جامعة فرانكلين في كولومبوس أوهايوهي افضل مثال لهذه الحالة . حيث تم تسجيل العديد من الشكاوي حول تدريس الاحصاء حيث يعتبر انهاء متطلب الاحصاء بنجاح جزءا اساسيا و شرطا من شروط التخرج لطلبة الاعمال و الفنون الجميلة و التكنولوجيا و الصحة و الادارة العامة .
تم تشكيل فريق عمل متخصص في آذار من عام 2012 لدراسة الاداء الضعيف و استنزاف الطلبة في مادة رياضيات 215 و مبادئ الاحصاء . النتائج التي توصل اليها فريق العمل أكدت وجود مشاكل كبيرة في كلتا المادتين . حيث قام أحد أعضاء فريق العمل و الذي يتمتع بخلفية علمية في علم السلوكيات بتغير هذه المشاكل و ضعف الادارة الى اختلاف اساليب التعليم بين مدرسي الاحصاء و طلابهم . حيث ان المدرسين يفضلوا ان يدرسوا المادة حسب ما تعلموها من أساتذتهم و و فقا لطريقة ادراكهم لها , مما قد لا يكون الاسلوب الامثل لتعليمها لكل الطلاب من عمليات و اساليب مختلفة مما قد يشكل عائقا امام فهم الطلبة للاحصاء و إتقانها
لمساعدة عمداء كليات الفنون و العلوم و التكنولوجيا , تم تطوير و تطبيق دراسة بحثية لقياس أثر الاساليب التعليمية المختلفة على اداء الطلبة من خلال علاماتهم النهائية في المادة .
تصف هذه الورقة الخلفية العلمية للمادة و الفرضيات القابلة للاختبار, و تصميم البحث , النتائج , الخلاصة و الآثار و التطبيقات الدولية و التوصيات الارشادية و التي تأتي من الدراسة .

**الكلمات الدالة:** تعليم الرياضيات, الأساليب الادراكية, الارشاد الاحصائي

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Italian Abstract*

Does Cognitive Style Make a Difference in Learning Statistical Concepts?

# Lo stile cognitivo fa la differenza nell'apprendere concert statistici?

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**Abstract**

Molti studenti universitari hanno problemi ad apprendere per la prima volta aspetti pratici e concettuali. Le conseguenti frustrazioni sono frequenti e il completamento di un corso può essere ritardato fino al termine del programma a causa delle difficoltà percepite. Questo avviene alla Franklin University in Columbus, Ohio, dove storicamente gli studenti hanno fatto molte contestazioni riguardo all'insegnamento della statistica. Completare con successo corsi di statistica è divenuto un requisito per un diploma con enfasi in economia, arti, tecnologia, salute e pubblica amministrazione.

E' stato creato un gruppo di lavoro nel Marzo 2012 per investigare le scarse prestazioni sul tema MATH215 concetti statistici. Il gruppo di lavoro ha identificato problemi significativi da parte degli studenti in entrambe le aree. Uno dei membri del gruppo con un background in scienze del comportamento, ha suggerito che la causa potenziale dello scarso livello di prestazioni riguardo a temi di statistica potrebbe essere la conseguenza di una differenza negli stili di apprendimento fra studenti e insegnanti di statistica. Questo con il presupposto di base che gli istruttori preferiscono insegnare nello stile in cui loro preferiscono apprendere che potrebbe essere in contrasto rispetto allo stile di apprendimento preferito dagli studenti. Questa disparità crea difficoltà per gli studenti a comprendere e gestire al meglio il materiale statistico.

Con il supporto del Preside del College of Arts, Sciences and Technology è stato sviluppato e implementato un progetto di ricerca riguardante il diverso impatto degli stili di apprendimento rispetto alla valutazione finale ottenuta. Lo studio describe il contesto, le ipotesi che si possono testare, il disegno della ricerca, le conclusioni e le implicazioni nazionali e internazionali inclusi raccomandazioni provenienti dallo studio stesso..

**Parole chiave:** [educazione matematica, stili cognitivi, istruzioni riguardanti la statistica]

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Chinese Abstract*

Does Cognitive Style Make a Difference in Learning Statistical Concepts?

# 认知风格对统计概念学习的影响

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## 摘 要

对许多首次接触统计概念的高校学生来说，他们常常感到难于理解教学材料中概念性和操作性的内容。这种挫折感在整个学习过程中经常出现，并一直延续到学生将近毕业之时。位于俄亥俄州哥伦布市的富兰克林大学也存在同样的情况。一直以来，学生对统计教育的投诉很多。由于统计课程是其他诸多专业如商科、文科、科技、卫生、公共管理等的基础课程， 成功地完成统计方面的学习对学生来说至关重要。

富兰克林大学自2012年三月起成立了一个专门的调查小组，来调查统计课程Math215中学生流失和成绩不佳的原因。调查小组发现无论学生流失还是成绩不佳都存在相同的原因。调查小组其中一个具有行为科学背景的成员认为，在统计课程学生表现不佳可能是教师和学生之间的学习风格差异的造成的。即教师喜欢用他们喜欢的学习风格来开展教学，但这往往违背学生自己更喜欢的教学风格。教师与学生之间学习风格期望的差异，导致部分学生理解和掌握统计内容的困难。

在艺术、科学与技术学院的支持下，研究小组对上述假设进行验证，并测定学习风格差异对课程成绩的影响。
本文描述了这一研究的背景、可检验假设、研究设计、结论、以及对实际教学的启示。]

**关键词:** 数学教育、认知风格、统计教学

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