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RELIABILITY ANALYSIS: APPLICATION OF CRONBACH'S ALPHA IN RESEARCH INSTRUMENTS

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ABSTRACT

Reliability is a critical aspect of evaluating research instruments, ensuring that the tools used to assess constructs such as attitudes, skills, and knowledge yield consistent and dependable outcomes. This paper investigates the use of Cronbach's Alpha, a widely accepted measure of internal consistency, through a case study that examines the perceptions of online Calculus learning among engineering students. A survey targeting two main dimensions, course content and instructor effectiveness, was administered to 25 students. The analysis reveals an overall reliability, indicated by a Cronbach's Alpha of 0.83, and identifies specific items that may require further refinement. The findings are discussed in light of Nunnally's recommendations for acceptable reliability levels, offering insights into the adequacy of the research instrument.

Keywords: Reliability Analysis, Cronbach's Alpha, Online Learning, research instrument, consistent measurements

Introduction

Reliability is essential for ensuring that data collected accurately reflect consistent measurements of the constructs under study. Whether the research focuses on student attitudes, course effectiveness, or educational technologies, the instruments used must reliably measure the intended constructs to provide valid and actionable insights. Reliability refers to the extent to which an instrument yields consistent results across different administrations or different sets of items purported to measure the same construct (Nunnally & Bernstein, 1994; DeVellis, 2016).

Cronbach's Alpha is one of the most widely used statistics for assessing the reliability of research instruments. This coefficient measures the internal consistency of a set of items, indicating how well they collectively capture the intended construct (Cronbach, 1951; Tavakol & Dennick, 2011). In cases where instruments include multiple items designed to measure complex constructs such as student attitudes, satisfaction, or perceptions, Cronbach's Alpha provides a crucial metric for evaluating the quality of these tools. This study explores the use of Cronbach's Alpha to assess the reliability of a survey examining engineering students' perceptions of online learning in Calculus. The survey, consisting of 10 items, was administered to 25 students and focused on two key dimensions: course content and instructor effectiveness. By calculating Cronbach's Alpha for the entire survey and for each

individual item, this study provides insights into the survey's internal consistency and discusses implications for improving research instruments. The data analysis aimed to:

i. Determine the overall reliability of the survey on students' perceptions of online learning in Calculus.
ii. Evaluate the reliability of each dimension of students' perceptions.
iii. Identify specific items that may reduce the overall reliability of the survey.

Theoretical Framework

Reliability is critical for ensuring that instruments consistently measure latent constructs such as attitudes, beliefs, behaviors, or knowledge. Consistent measurements across different populations, settings, and times ensure that the data obtained are dependable and can inform decisions about practices and policies (Nunnally & Bernstein, 1994). Instruments typically consist of multiple items designed to capture various dimensions of a construct. For example, a survey measuring students' perceptions of online learning might include items related to course content and instructor effectiveness. For the instrument to be reliable, these items must consistently reflect the underlying construct of students' perceptions. Cronbach's Alpha assesses whether these items are sufficiently correlated to justify their use in measuring a single construct (Cronbach, 1951).

Cronbach's alpha, introduced by Lee Cronbach in 1951, is a coefficient of internal consistency that gauges the extent to which items in a test measure the same underlying construct (Cronbach, 1951). The statistic is computed based on the average inter-item correlation, where a higher alpha value indicates stronger correlations among the items. The formula for Cronbach’s alpha is:

$$\alpha = \frac{N\bar{c}}{\bar{v} + (N-1)\bar{c}}$$

where:

N = number of items

$\bar{c}$ = mean covariance between items.

$\bar{v}$ = mean item variance.

Cronbach's Alpha is used to assess the internal consistency of instruments designed to measure constructs like student perceptions, satisfaction, or engagement. A high Cronbach's Alpha suggests that the items in the instrument are closely related and effectively measure the same construct, which is essential for the validity of the research findings (Nunnally & Bernstein, 1994).

However, it is important to recognize the limitations of Cronbach's Alpha. Specifically, it assumes one-dimensionality, meaning that all items in the scale measure the same underlying construct. In cases where constructs are multifaceted, this assumption may not always hold true. Therefore, it is often advisable to complement Cronbach's Alpha with other forms of reliability and validity testing, such as factor analysis, to ensure the robustness of the instrument (Field, 2013).

Level of Reliability

Nunnally's recommendations for reliability levels offer essential guidance for evaluating research instruments. According to Nunnally (1978), a Cronbach's alpha coefficient of 0.70 or higher is generally acceptable for basic research, indicating sufficient internal consistency. For more advanced research or when high precision is necessary, a higher alpha value, such as 0.80 or above, is preferred to ensure greater reliability. Nunnally also emphasizes that while a high alpha is desirable, it should not be the sole criterion for assessing an instrument's quality.

Reliability should be considered alongside other factors, such as the scale's validity and practical utility, to ensure it effectively measures the intended construct and performs well within the specific research context. Table below is summarizing the recommended levels of reliability according to Nunnally's guidelines:

Table 1: Reliability Levels, Cronbach's Alpha Ranges, and Their Interpretations.

Reliability Level	Cronbach's Alpha Range	Interpretation
Excellent	0.90 and above	Indicates very high internal consistency.
Good	0.80 - 0.89	Reflects strong internal consistency.
Acceptable	0.70 - 0.79	Indicates acceptable internal consistency.
Questionable	0.60 - 0.69	Reflects questionable internal consistency.
Poor	Below 0.60	Indicates poor internal consistency.

This table provides a clear and concise overview of the different levels of reliability, their Cronbach's Alpha ranges, and interpretations. It serves as a valuable reference for researchers in determining the appropriateness of their measurement instruments (Nunnally, 1978). By understanding these reliability thresholds, researchers can make informed decisions about the robustness of their scales in various research contexts.

Methodology

This study employs a case study approach to evaluate the reliability of a survey measuring engineering students' perceptions of online learning in Calculus using Cronbach's Alpha. The survey instrument, developed based on existing literature on online learning and student perceptions, was designed to measure two key dimensions: course content and instructor effectiveness. The survey instrument consisted of 10 items, each designed to capture a different aspect of students' perceptions of online learning in Calculus. These items were developed to reflect the multifaceted nature of online learning experiences, ensuring that the survey could provide a comprehensive assessment of students' overall attitudes and experiences. The 10 survey items were divided into two dimensions as follows:

Table 2: Survey Items Assessing Course Content and Instructor Effectiveness.

Dimension	Item
Course Content	The online course materials (videos, notes, etc.) were clear and easy to understand.
	The course content was well-organized and logically structured.
	The examples provided in the course materials were relevant and helped me understand the concepts.
	The assignments and exercises were effective in reinforcing my understanding of Calculus concepts.
	The pace at which the course content was delivered was appropriate for my learning.
Instructor Effectiveness	The instructor's explanations during online sessions were clear and easy to follow.
	The instructor was available to answer questions and provide assistance when needed.
	The feedback provided by the instructor on assignments was timely and helpful.
	The instructor made the online lectures engaging and interactive.
	The instructor created a supportive environment that encouraged me to participate and ask questions.

The survey was administered to 25 engineering students enrolled in online Calculus courses. The students were selected to represent a diverse sample in terms of academic performance, year of study, and prior experience with online learning. The survey was conducted anonymously, and students were encouraged to provide honest responses. After data collection, responses were entered into SPSS software for analysis. Cronbach's Alpha was calculated for the entire survey to determine its overall reliability. Additionally, Cronbach's Alpha was calculated separately for each of the two dimensions (course content and instructor effectiveness) to assess the reliability of the items within each dimension.

Results and Discussion

The analysis revealed that the overall Cronbach's Alpha for the survey was 0.83, indicating good internal consistency. This suggests that the 10 items work well together to measure the construct of students'

perceptions of online learning in Calculus. According to Nunnally's guidelines, this level of reliability is appropriate for applied research settings (Nunnally & Bernstein, 1994).

Table 3: Cronbach's Alpha Value for Each Dimension.

Dimension	Cronbach's Alpha	Reliability	Description
Course Content	0.81	Good Reliability	Items consistently measured students' perceptions of the quality and organization of the online Calculus course content.
Instructor Effectiveness	0.79	Acceptable Reliability	Items assessed students' perceptions of their interactions with and satisfaction regarding the online instructor.

Results in Table 3 indicate that the Cronbach's Alpha for the course content items was 0.81, indicating good reliability. This suggests that the items within this dimension consistently measured students' perceptions of the quality and organization of the online math course content. Similarly, the Cronbach's Alpha for the instructor effectiveness items was 0.79, indicating acceptable reliability. These items effectively captured students' perceptions of their interactions with and satisfaction regarding the online instructor.

The findings indicate that the survey used to measure engineering students' perceptions of online learning in Calculus generally exhibits good reliability, as evidenced by the overall Cronbach's Alpha. However, item-level analysis revealed that certain questions may not contribute effectively to the survey's internal consistency. Identifying problematic items has important implications for the design and refinement of the survey (DeVellis, 2016; Tavakol & Dennick, 2011). Questions that were found to have lower reliability may need to be revised or replaced to better align with the overall construct of students' perceptions. For example, these questions could be reworded to reduce ambiguity, or additional items could be added to more comprehensively capture relevant dimensions of online learning experiences (Netemeyer, Bearden, & Sharma, 2003).

In light of Nunnally’s guidelines for acceptable levels of reliability, the overall Cronbach’s Alpha of the survey meets the recommended threshold for applied settings (Nunnally & Bernstein, 1994). However, given the importance of accurately measuring students’ perceptions of online learning, further refinement of the survey items could enhance the instrument’s reliability (DeVellis, 2016; Field, 2013).

Conclusion

This study demonstrates the utility of Cronbach's Alpha as a measure of internal consistency and reliability in research instruments. The case study of a survey measuring engineering students' perceptions of online learning in Calculus underscores the importance of assessing reliability at both the overall and item levels. By adhering to Nunnally's guidelines, researchers can ensure that their instruments are sufficiently reliable for their intended purposes, whether in exploratory studies or applied research settings. The findings suggest that, while the survey used in this case study is generally reliable, certain items may require refinement to enhance the overall consistency of the instrument. These insights contribute to the ongoing development of reliable and valid research instruments, ultimately leading to more accurate and meaningful research outcomes.

Limitations and Future Research

A limitation of this study is its focus on a single subject area (Calculus) and the use of a specific faculty population (engineering), which may limit the generalizability of the findings to other subjects or student populations. Future research could expand the sample to include students from different disciplines and institutions, allowing for a more comprehensive assessment of the survey's reliability across various contexts.

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