

Making sense of Cronbach's alpha

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Medical educators attempt to create reliable and valid tests and questionnaires in order to enhance the accuracy of their assessment and evaluations. Validity and reliability are two fundamental elements in the evaluation of a measurement instrument. Instruments can be conventional knowledge, skill or attitude tests, clinical simulations or survey questionnaires. Instruments can measure concepts, psychomotor skills or affective values. Validity is concerned with the extent to which an instrument measures what it is intended to measure. Reliability is concerned with the ability of an instrument to measure consistently.¹ It should be noted that the reliability of an instrument is closely associated with its validity. An instrument cannot be valid unless it is reliable. However, the reliability of an instrument does not depend on its validity.² It is possible to objectively measure the reliability of an instrument and in this paper we explain the meaning of Cronbach's alpha, the most widely used objective measure of reliability.

Calculating alpha has become common practice in medical education research when multiple-items measures of a concept or construct are employed. This is because it is easier to use in comparison to other estimates (e.g. test-retest reliability estimates)³ as it only requires one test administration. However, in spite of the widespread use of alpha in the literature the meaning, proper use and interpretation of alpha is not clearly understood.^{1-4,5} We feel it is important, therefore, to further explain the underlying assumptions behind alpha in order to promote its more effective use. It should be emphasised that the purpose of this brief overview is just to focus on Cronbach's alpha as an index of reliability. Alternative methods of measuring reliability based on other psychometric methods, such as generalisability theory or item-response theory, can be used for monitoring and improving the quality of OSCE examinations⁶⁻⁸, but will not be discussed here.

What is Cronbach alpha?

Alpha was developed by Lee Cronbach in 1951⁹ to provide a measure of the internal consistency of a test or scale; it is expressed as a number between 0 and 1. Internal consistency describes the extent to which all the items in a test measure the same concept or construct and hence it is

connected to the inter-relatedness of the items within the test. Internal consistency should be determined before a test can be employed for research or examination purposes to ensure validity. In addition, reliability estimates show the amount of measurement error in a test. Put simply, this interpretation of reliability is the correlation of test with itself. Squaring this correlation and subtracting from 1.00 produces the index of measurement error. For example, if a test has a reliability of 0.80, there is 0.36 error variance (random error) in the scores ($0.80 \times 0.80 = 0.64$; $1.00 - 0.64 = 0.36$).¹² As the estimate of reliability increases, the fraction of a test score that is attributable to error will decrease.³ It is of note that the reliability of a test reveals the effect of measurement error on the observed score of a student cohort rather than on an individual student. To calculate the effect of measurement error on the observed score of an individual student, the standard error of measurement must be calculated (SEM).¹⁰

If the items in a test are correlated to each other, the value of alpha is increased. However, a high coefficient alpha does not always mean a high degree of internal consistency. This is because alpha is also affected by the length of the test. If the test length is too short, the value of alpha is reduced.¹¹⁻¹⁴ Thus, to increase alpha, more related items testing the same concept should be added to the test. It is also important to note that alpha is a property of the scores on a test from a specific sample of testees. Therefore investigators should not rely on published alpha estimates and should measure alpha each time the test is administered.¹⁵

Use of Cronbach's alpha

Improper use of alpha can lead to situations in which either a test or scale is wrongly discarded or the test is criticised for not generating trustworthy results. To avoid this situation an understanding of the associated concepts of internal consistency, homogeneity or unidimensionality can help to improve the use of alpha. Internal consistency is concerned with the interrelatedness of a sample of test items, whereas homogeneity refers to unidimensionality. A measure is said to be unidimensional if its items measure a single latent trait or construct. Internal consistency is a

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Intelligent Information and Database Systems Ngoc Thanh Nguyen, Ford Lumban Gaol, Tzung-Pei Hong, Bogdan Trawiński, 2019-04-02 The two volume set LNAI 11431 and 11432 constitutes the refereed proceedings of the 11th Asian Conference on Intelligent Information and Database Systems ACIIDS 2019 held in Yogyakarta Indonesia in April 2019 The total of 124 full papers accepted for publication in these proceedings were carefully reviewed and selected from 309 submissions The papers of the first volume are organized in the following topical sections knowledge engineering and semantic web text processing and information retrieval machine learning and data mining decision support and control systems computer vision techniques and databases and intelligent information systems The papers of the second volume are divided into these topical sections collective intelligence for service innovation technology management E learning and fuzzy intelligent systems data structures modelling for knowledge representation advanced data mining techniques and applications intelligent information systems intelligent methods and artificial intelligence for biomedical decision support systems intelligent and contextual systems intelligent systems and algorithms in information sciences intelligent supply chains and e commerce sensor networks and Internet of Things analysis of image video movements and brain intelligence in life sciences and computer vision and intelligent systems *International Journal of Finance and Policy Analysis* Siddhartha Sarkar, **Handbook of Research on Pedagogical Models for Next-Generation Teaching and Learning** Keengwe, Jared, 2017-10-31 Every generation of students comes to the classroom with different needs than that of their predecessors Implementing new methods and styles of teaching to meet these diverse needs will provide students with the best chance of success in their educational careers The Handbook of Research on Pedagogical Models for Next Generation Teaching and Learning is a critical scholarly source that examines the most effective and efficient techniques for implementing new educational strategies in a classroom setting Featuring pertinent topics including mixed reality simulations interactive lectures reflexive teaching models and project based learning this is an ideal publication for educators academicians students and researchers that are interested in discovering more about the recent advances in educational fields *Working Dogs: Form and Function, Volume II* Cynthia M. Otto, Nathaniel James Hall, Wendy Irene Baltzer, 2021-09-29 *Handbook of Research on Innovation and Development of E-Commerce and E-Business in ASEAN* Almunawar, Mohammad Nabil, Anshari, Muhammad, Ariff Lim, Syamimi, 2020-08-28 Business to consumer B2C and consumer to consumer C2C e commerce transactions including social commerce are rapidly expanding although e commerce is still small when compared to traditional business transactions As the familiarity of making purchases using smart devices continues to expand many global and regional investors hope to target the ASEAN region to tap into the rising digital market in this region The Handbook of Research on Innovation and Development of E Commerce and E Business in ASEAN is an essential reference source that discusses economics marketing strategies and mobile payment systems as well as digital marketplaces communication

technologies and social technologies utilized for business purposes Featuring research on topics such as business culture mobile technology and consumer satisfaction this book is ideally designed for policymakers financial managers business professionals academicians students and researchers *Towards An Era of Puhui Policy* Yu Zhou,Yong Jiang,Xingjian Zhu,2024-09-04 In China the puhui early care and education ECE program a national public policy was officially launched in 2010 to improve the affordability accessibility and quality of ECE Based on a five year research project this book explores the development and practice of this ambitious reform campaign with national empirical evidence The authors evaluate the puhui ECE system e g puhui early education policy puhui kindergarten services puhui child care services and total teacher compensation from the perspective of universal ECE provision for all children They focus on children from disadvantaged families such as migrant children children with special needs and children from low socioeconomic families by emphasizing the targeted provision of ECE based on the principle of educational equity In addition they explore the innovative ways to optimize the structure quality and efficiency of puhui ECE provision by introducing an innovative provider with the participation of social organizations China Welfare Institute and three innovative forms of provision including village kindergarten small scale urban kindergarten and compensation for children with special needs The book will be of interest to policymakers scholars and researchers in early childhood education education policy and education development

Researching Ageing Maria Łuszczynska,2020-06-07 This book explores the diversity of methodological approaches to researching ageing considering which methodological paradigm best captures the phenomenon Interdisciplinary in scope it brings together research from scholars from Austria Canada France Hong Kong Israel Poland UK and USA to uncover the conditions under which qualitative and quantitative approaches to research on ageing can best be reconciled and rendered complementary Presenting international reflection on methods for studying old age from a variety of research backgrounds Researching Ageing showcases the latest research in the field and will appeal to scholars across the social sciences including sociology demography psychology economics and geography with interests in gerontology ageing and later life

Proceedings of the ICSDI 2024 Volume 1 Yasser Mansour,Umashankar Subramaniam,Zahiraniza Mustaffa,Abdelhakim Abdelhadi,Mohamed Ezzat,Eman Abowardah,2024-11-16 This book offers a comprehensive overview of the latest research innovations and practical applications in the field of sustainability with a focus on construction materials and their use in building and civil engineering structures As an outcome of the 2nd International Conference on Sustainability Developments and Innovations ICSDI 2024 the book presents a selection of peer reviewed papers from prominent researchers and engineers around the world The book covers a broad range of topics including construction and resilient infrastructure sustainable manufacturing industrial ecology renewable energy future cities sustainable built environment design and policies regulations and economics for achieving sustainable development goals This book will serve as an essential reference for graduate students engineers and scientists as well as industry professionals working in the field

of sustainability The book aligns with the scope of book series scope which aims to contribute to progress in the construction sciences techniques and industries through communication between research and practice It is also a valuable resource for practitioners and policymakers who are interested in understanding the latest technological advancements and innovations in sustainability to solve real world problems

How Do Businesses and Generations Maintain Its Legacy? Krakrafaa Thompson Tenent Bestman, 2018-02-23 Employees exit an organization with 80% of the knowledge they have acquired without transferring it to others This colossal loss of intellectual assets is even more in terms of parent to child legacy transfer Several factors may have contributed to this immense generational memory loss First the knowledge seekers do not know what to do on how to influence the knowledge sources to share their skills and experiences and may not even understand the characteristics of the knowledge they intend to access from the knowledge sources Second these intellectual assets such as skills and experiences they intend to access give the knowledge sources their comparative advantage in the society and worst still they are not on the pages of procedures or other documented format but mainly domicile in the heads of the possessors and hence not visible to others Third people also regard their skills and experiences as invaluable intellectual assets and hence do not want to easily share it with others These are some of the constraints knowledge seekers face whether in an organization or the society while trying to access the information they require in creating value in their respective domains Eventually the legacies transferred to the knowledge seekers fall short of what would have been transferred if the knowledge seeker knows otherwise This book bridges this gap by providing a strategic and systematic approach on how a knowledge seeker may apply social interaction variables and its hierarchical effect on knowledge transfer to influence a knowledge source to share his or her intellectual assets that he or she might not ordinarily be willing to share with any knowledge seeker

Integrating Cutting-Edge Technology Into the Classroom Chee, Ken Nee, Sanmugam, Mageswaran, 2024-04-09 The upheavals of technological advancements and the COVID 19 pandemic have reshaped the traditional contours of education creating a pressing need for innovative solutions to bridge the gap between traditional classrooms and the evolving demands of remote or hybrid learning As we grapple with these changes it becomes increasingly evident that the integration of new technology is not just a preference but a necessity to ensure educational resilience and adaptability Integrating Cutting Edge Technology Into the Classroom delves into the profound impact of technological disruptions on teaching methodologies student engagement and overall learning outcomes This book doesn't merely document technological advancements it is a trigger for a fundamental shift in the research community By showcasing real world applications and their impact on student achievement the book propels researchers into uncharted territories sparking collaboration and dialogue Through in depth case studies research findings and expert perspectives it provides a platform for academics technologists and educators to explore the opportunities and challenges posed by advanced technologies in education As an indispensable resource it fosters a collaborative environment that propels educational technology to new

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 2025 University of Vienna Austria **Sharing the Road** Dengbo He, Xiaotong Sun, Huan Yu, 2025-03-11 With the
 advancements in sensor and computation technologies connected autonomous vehicle CAV services are being tested and
 deployed on public roads sharing the road with human driven vehicles HVs This brings challenges to traffic safety due to
 uncertainty in HVs behaviors To address these challenges Sharing the Road offers solutions to create a safer world where
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 real life examples are provided leaving the reader with a detailed vision of the future of a mixed traffic world This title will
 appeal to professionals at any career stage in the fields of human factor engineering traffic engineering urban design and
 vehicle engineering **Cyberspace** Evon Abu-Taie, Issam H. Al Hadid, Abdelkrim El Mouatasim, 2020-06-17 Parallel to the
 physical space in our world there exists cyberspace In the physical space there are human and nature interactions that
 produce products and services On the other hand in cyberspace there are interactions between humans and computer that
 also produce products and services Yet the products and services in cyberspace don't materialize they are electronic they are
 millions of bits and bytes that are being transferred over cyberspace infrastructure *AI and New Forms of Exclusion*
 González Alvarado, Tania Elena, Lampón, Jesús F., 2025-07-25 As a society we have made progress in raising awareness of
 exclusion how to avoid it and in creating inclusive mechanisms This has involved the visibility of citizen science All of this is
 in parallel with the advances in computer systems artificial intelligence AI large databases and the systematization of
 services A contradictory world has been created in which a new social exclusion is born due to computer biases and poor
 data quality in contrast to a society with greater sensitivity to these issues It is essential to address these challenges through
 social economic and environmental dimensions AI and New Forms of Exclusion explore the contradictions of inclusion in the
 face of a more sensitive society accustomed to virtual life This book discusses how AI affects decision making and how it has
 been integrated into public systems Covering topics such as algorithmic discrimination machine learning and social
 responsibility this book is an excellent resource for entrepreneurs investors academicians students policymakers and more
The Finance-Innovation Nexus William A. Barnett, Bruno S. Sergi, 2024-12-10 Topics covered in this volume include CEO
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banks risk taking as well as social capital

Proceedings of the 8th International Conference on Education

Innovation (ICEI 2024) Ima Widiyanah, Muhammad Nurul Ashar, Ali Fakhrudin, Ahmad Abdullah Zawawi, Susan Ledger, Tony Loughland, Andi Kristanto, Mohd Nazri Bin Abdul Rahman, Laily Maulida Septiana Harti, Achmad Wachidul Kohar, Mochamad Nursalim, 2025-04-01 This is an open access book The organizing Committee of the 8th International Conference on Education Innovation ICEI 2024 is an interdisciplinary platform for teachers researchers practitioners and academicians to present and discuss the latest research findings concerns as well as practical challenges encountered and solutions adopted in the fields of green education innovation in managing sustainable environment

Translational Radiation Oncology

Jeffrey A. Bakal, Daniel Kim, David Wazer, Adam E.M. Eltorai, 2023-08-03 Translational Radiation Oncology covers the principles of evidence based medicine and applies them to the design of translational research The book provides valuable discussions on the critical appraisal of published studies and recent developments in radiation oncology allowing readers to learn how to evaluate the quality of such studies with respect to measuring outcomes and make effective use of all types of evidence By reading this book researchers have access to a practical approach to help them navigate challenging considerations in study design and implementation It is a valuable resource for researchers oncologists and members of biomedical field who want to understand more about translational research applied to the field of radiation oncology Translational medicine serves as an indispensable tool in grant writing and funding efforts so understanding how to apply its principles to research is necessary to guarantee that results will be impactful to patients Provides a clear process for understanding designing executing and analyzing clinical and translational research Presents practical step by step guidance to help readers take ideas from the lab to the bedside Written by a team of oncologists radiologists and clinical research experts that fully cover translational research in radiation oncology

Recent Developments in Technology-Enhanced and Computer-Assisted Language Learning Zou, Bin, Thomas, Michael, 2019-12-06 The pace at which technology changes has created unique challenges in the integration of such technologies into language teaching and learning Innovative pedagogies and strategies must be developed that adapt to these changes and accommodate future technological changes Recent Developments in Technology Enhanced and Computer Assisted Language Learning is an essential research publication that focuses on technological influences on language education and applications of technology in language learning courses including foreign and second language learning Featuring an array of topics such as artificial intelligence teacher preparation and distance learning this book is ideal for teachers language instructors IT specialists instructional designers curriculum developers researchers education professionals academicians administrators practitioners and students

Knowledge Management and Sustainability David Israel Contreras-Medina, Julia Pérez Bravo, Elia Socorro Díaz Nieto, 2021-12-29 Based on the importance of human beings as creators and managers of knowledge towards the achievement of sustainability in the current digital age this book is an effort to present many studies taking individuals as

centers of knowledge and starting points for environmental social and economic development From various theoretical and empirical studies developed by researchers from Mexico Colombia and Brazil this book presents in an ordered sequence the individual as the creator of knowledge the role of human beings as knowledge managers with and for sustainability the opportunities for knowledge sharing in virtual research collaborations for sustainability and the advantages and disadvantages with and for sustainability from a human centered perspective in the digital era Moreover this text describes the antecedents of competitive advantage in a sustainable cooperative network knowledge management in technology projects an empirical study of knowledge management of tutorial intervention a model of processes and knowledge management to increase competitiveness the role of Information and Communication Technologies ICT for managing sustainable practices finishing with knowledge management trends with and for sustainability from a human centered perspective in the digital era Offering an innovative approach this book seeks to expand the understanding of the theme of knowledge management and sustainability from the perspective of the human resource as a generator of knowledge There is mounting focus on knowledge intensive work and sustainable development in the corporate world In light of these trends this edited volume will be of value to researchers academics professionals and advanced students in the fields of management environment and sustainability and development studies

Handbook of Research on Entrepreneurship, Innovation, and Internationalization Teixeira, Nuno Miguel, Costa, Teresa Gomes da, Lisboa, Inês Margarida, 2019-06-28 In a global and increasingly competitive world companies must be aware of important drivers Entrepreneurship and innovation are important contributions to the development of economies and creation of employment gaining relevance in the business context due to a more complex market and needs for higher differentiation The Handbook of Research on Entrepreneurship Innovation and Internationalization provides key data to business managers on dealing with entrepreneurship as well as for creating networks and complementarities for leveraging the firm s activity in order to help plan and control innovation and internationalization processes to avoid risk and increase the firm s value The content within this publication includes topics such as family business economics and business education It is designed for entrepreneurs managers researchers academicians and students

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