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Sir Francis Galton's Philosophy of Measurement Science and Its Relevance for the Development of the Psychometric Paradigm

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Abstrak

Artikel ini membahas asal usul paradigma psikometri dan ketergantungannya pada gagasan bahwa atribut mental dapat diukur. Asumsi Galton bahwa atribut mental dapat dilihat melalui tindakan tertentu sebagai respons terhadap situasi tertentu adalah salah arah. Artikel ini menyoroti sifat kausalitas terner, yang melibatkan sebab, akibat, dan bidang sebab akibat tertentu. Penyebab yang sama mungkin tidak menghasilkan akibat yang sama dalam bidang sebab-akibat yang berbeda dan sebab-sebab yang berbeda dapat menghasilkan akibat yang sama dalam bidang sebab-akibat yang berbeda. Hubungan antara ukuran yang dapat diamati dan aspek karakter tidak jelas dan indeks tidak langsung dari atribut mental pada dasarnya bersifat ambigu. Artikel ini berfokus pada peran Francis Galton dalam membangun keyakinan ini dan berpendapat bahwa alasannya cacat dan dipengaruhi oleh filosofi sains Pythagoras dan keinginannya untuk menampilkan eugenika sebagai sains. Tulisan ini bertujuan untuk mendeskripsikan teori Sir Francis Galton mengenai ilmu pengukuran dan relevansinya dengan psikometri. Menggunakan metode tinjauan pustaka pada berbagai sumber (artikel ilmiah dan buku teks) yang berkaitan dengan topik pembahasan. Secara keseluruhan, artikel ini menantang asumsi bahwa atribut mental pada dasarnya bersifat kuantitatif dan mendukung pemahaman yang lebih berbeda tentang pengukuran dalam psikometri.

Kata Kunci: filsafat ilmu pengukuran; psikometri; Tuan Francis Galton

Abstract

This article discusses the origins of the psychometric paradigm and its reliance on the notion that mental attributes can be measured. Galton's assumption that mental attributes can be discerned through definite actions in response to definite situations is misguided. This article highlights the ternary nature of causality, involving causes, effects, and specific causal fields. The same cause may not produce the same effect in different causal fields, and different causes may produce the same effect in different causal fields. The relationships between observable measures and aspects of character are unclear, and indirect indices of mental attributes are inherently ambiguous. This article focuses on Francis Galton's role in establishing these beliefs and argues that his reasoning was flawed and influenced by Pythagoras' philosophy of science and his desire to present eugenics as science. This paper aims to describe Sir Francis Galton's theory regarding the science of measurement and its relevance to psychometrics. Using the literature review method on various sources (scientific articles and textbooks) related to the topic of discussion. Overall, this article challenges the assumption that mental attributes are inherently quantitative and argues for a more nuanced understanding of measurement in psychometrics.

Keywords: measurement science philosophy; psychometrics; Sir Francis Galton

1. Introduction

Measurement is often considered an effective method for obtaining information about the empirical world. When someone claims to have taken measurements, this implies that the information obtained has a number of advantages, such as reliability, precision and objectivity,

compared to information obtained through other means, such as based on guesswork or intuition based on personal data. However, it is important to remember that it is not always clear on what basis an activity is called a measurement that confers the epistemic and social authority generally accorded to that activity. In other words, we need to ask what really defines an activity as a measurement that guarantees the quality of its results, and whether the answer to this question can be found independently, without considering the context of its application (Mari, 2023).To address a series of questions regarding knowledge acquisition and validation, it is essential to delve into fundamental inquiries about the nature of existence, the process of acquiring knowledge, and how knowledge can be expressed. These inquiries have been pivotal in the evolution of philosophy, particularly in relation to science, ontology, epistemology, and semiotics, influencing discussions on measurement across various scientific disciplines, as outlined in this chapter aiming to provide a concise overview of the historical philosophical perspectives on measurement (Mari, 2023).

Recently, there has been a growing interest in the measurement of various human attributes, such as knowledge and skills, cognitive and physical abilities, personality traits, affective and motivational characteristics, psychological states, attitudes, values, and preferences. This trend raises the fundamental question of whether these attributes need to have an existence independent of human cognition, meaning they must be ontologically objective to be considered suitable for measurement (Searle, 1992; Maul, 2013). Furthermore, scientific inquiry, which aims to provide objective information, emphasizes the importance of epistemic objectivity in studying these attributes and phenomena. Galton (1869) is an important figure in the domain of psychometrics, widely known for laying the foundations for the field in 1869. Although not the originator of mental tests or test score theory, he established a psychometric framework based on the fundamental belief that mental attributes can be measured quantitatively. However, the truth of this assumption is still a matter of skepticism among scholars. The essence of measurement in all scientific disciplines lies in the prerequisite of a quantitative structure in the attributes being investigated, which allows these attributes to be ordered and aggregated. This prerequisite is rooted in the concept that measurement involves estimating the ratio of a unit of measurement, a task that depends on the existence of a quantitative framework. Consequently, determining whether an attribute is measurable requires empirical investigation to ensure the existence of a quantitative structure and the feasibility of ratio estimation (Michell, 1997). If attributes lack a quantitative structure, conventional measurements become unfeasible, prompting researchers to explore alternative methodologies such as classification or ordering. It is important to underscore the importance of measurement in the field of science, because measurement signifies a systematic effort to uncover the truth, not simply describing quantitative abstractions about natural phenomena.

Galton lacked empirical evidence supporting the notion that mental traits possessed measurable quantities, leading to lingering uncertainties regarding this idea. Consequently, the psychometric approach can be viewed as an imposition of theoretical constructs rather than being derived from empirical observations of mental phenomena. In his work in 1879, Galton characterized psychometrics as the practice of quantifying and ascribing numerical values to mental processes; however, it is crucial to recognize that the term "measurement" in this context does not strictly adhere to its conventional definition of quantification, but instead pertains to notions of similarity or comparison among mental attributes. Similarities with certain methodological practices emerge when attributes that seem important are less likely to be considered definitive criteria. Consequently, the methodology was modified to elevate these attributes to the status of adequacy and significance. An example of this phenomenon can be observed in the contemporary scenario through the redefinition of measurement by Stevens (1946) who characterized measurement as the process of assigning numerical values to objects or events based on predetermined rules. This conceptualization has been a fundamental principle in the field of psychology since the 1950s. Traditionally, measurement requires the use of numerical values, and attributes that may initially appear important (although inherently inadequate due to the varying use of numbers in various contexts such as enumeration and classification) are explicitly considered adequate and important for the measurement process (Stevens, 1946). Thus, this definition presents a description that is more aligned with the practical application of the measurement compared to the original definition. Galton (1883) considered himself to be the originator not only of psychometrics but also of eugenics, defined as the scientific effort to improve the genetic pool to facilitate the ascension of appropriate races or lineages in society. Assessment of cognitive capacity plays an important role in this effort.

Galton considered measurement to be a fundamental cornerstone of scientific inquiry and characterized his evaluation of cognitive abilities as a measurable form of judgment, suggesting that these abilities have a numerical essence. It is this idea, rooted in Galton's perspective that laid the foundation for the psychometric paradigm and emerged as a component in the evolution of this field of study. First and foremost to underline is that the perspective in question first appeared in Galton's work entitled "Hereditary Genius" in 1869. In addition, a deeper understanding of the reasons behind this statement can be achieved by delving into these arguments. Articulated in other publications by Galton, particularly his 1884 paper on the measurement of character. The basic principles inherent in this point of view raise questions because of its foundation in a perspective of reality that is heavily influenced by Pythagorean philosophy. It is also important to acknowledge the impact of Galton's belief that eugenics was a scientific field. Through his belief that eugenics was a scientific discipline that required measurement, Galton inherently argued that cognitive traits had measurable and measurable attributes. Therefore, through this article the researcher tries to explain three things, namely a brief history of measurement science, measurement characteristics, Sir Francis Galton's concept of measurement, and its relevance to psychometrics.

2. Method

This research uses a literature review design on various sources (Walter, 2018) related to the object of study with documentation methods such as scientific articles (i.e. Michell, 2022) and textbooks (i.e. Mari et al., 2023) related to measurement science. Francis Galton related to the research topic. Then, this research has three stages in studying Sir Francis Galton's science of measurement, namely starting with formulating questions, selecting literature sources, and analyzing, synthesizing and presenting findings. In short, this research examines the literature by carrying out critical analysis and interpretation of historical texts and ideas, focusing on the writings of Francis Galton and their relevance to psychometrics, which are reviewed using narrative descriptive analysis methods (Creswell & Poth, 2016).

3. Result and Discussion

a. A Brief History of Measurement Science

Himbert (2009) stated that the history of measurement science has been an important element in the development of science and technology, and has very long roots in human civilization. Measuring and numerating objects as well as quantifying the characteristics of simple systems has been an ancient practice found in various civilizations. For example, the link between units of measurement and money, which shows how measurement has an impact in the economic system.

Galton (1869) carried out measurement and numeration practices using the theory of errors applied to test scores, as well as physical measurements such as chest size. Galton then presented the important idea that the average of a number of observations, such as a test score or an individual's response to an item, could be used to estimate something closer to "true" about that individual. This idea became a key element in his research on the inheritance of intelligence and had a significant impact on the study of the inheritance of intellectual traits. In addition, Himbert (2009) stated that the historical development of measurement science is also closely related to the relationship between measurement and authority in the context of civilization, which highlights its important role in political and economic decision making. Furthermore, measurements to date have always undergone an evolutionary development in an effort to achieve precision and better understanding of the world around them, while considering the deep philosophical and historical aspects that influence the development of measurement science.

b. Measurement Characteristics

In the scientific and technical literature, we can find various characterizations regarding measurements, reflecting the great interest and complexity associated with this topic. This multiplicity of views can be explained by referring to several complementary criteria (Mari, 2013). For each criterion used, there appears to be a mismatch between the two different approaches. While this discrepancy has not stopped important developments in measurement science, a confusing situation like this is clearly not ideal. We would like to propose the view that this diversity may be the result of some stereotypes that influence thinking about measurement (Mari et al., 2017). Each of these approaches has a sound basis and is attractive because of its

simplicity, but their respective interpretations fail to take into account several important aspects of the complex measurement concept. To explain this, there are three main stereotypes in measurement (Mari et al., 2023), namely: 1) The naive realist stereotype focuses on measurements analogous to a transmission process, which in the ideal case identically transfers the true value of the measurable quantity to the measurable value provided by the measuring instrument, 2) The operational stereotype emphasizes that measurement is a purely procedural, model-free empirical process, which only provides information about the properties that interact with the measuring instrument, 3) The representationalist stereotype emphasizes that measurement is a process that maps properties to informational entities in a consistent way, so that information entities can be represented through informational entities.

In the course of history, it has been suggested that measurement can be characterized by referring to (Tal, 2020), namely: 1) Ontic reasons, namely measurement is a process designed to find the values possessed by the properties of an object, 2) Epistemic reasons, namely measurement is a process designed to produce correct, or at least credible, information about the properties you want to measure, 3) Pragmatic reasons, namely measurement is a process designed to suit the purpose of obtaining information about the properties you want to measure, 4) Formal reasons, namely measurement is a process designed to evaluate properties consistently through symbols.

c. Measurements of Sir Francis Galton

Galton (1869) can be considered a pioneer in the development of psychometrics. Although he did not invent mental tests or develop a theory of test scores directly, his role lies in refining the psychometric framework with his belief that mental attributes can be measured in quantitative terms. Galton's initial efforts in the field of mental measurement first appeared in his work entitled "Hereditary Genius" in 1869. His aim was to prove that ability, especially in terms of "genius" is not the result of learning, but is an innate characteristic of the individual. To measure genius, Galton used criteria of excellence reflected in a list of reference works of individuals recognized for their achievements in their fields. He attempted to show that highly superior individuals had a higher proportion of relatives than individuals in the general population. While there is no strong evidence to evaluate the adequacy of the evidence submitted (López-Beltran, 2006; Sweeney, 2001; Waller, 2002). What needs to be stated here is that Galton believed that natural abilities were attributes that could be measured, not just attributes that were in categories or ordered. This assumption is implicit in his comments about the nature of natural abilities.

The first example that can be taken is in the context of Galton's discussion of the natural abilities of "wranglers" in the Cambridge University examinations (1869). He observed that "the senior wranglers above mentioned had more than thirty or thirty-two times the ability of the lowest men on the honor roll". If natural abilities are merely orderly or categorical, the most conclusion that can be drawn about two individuals judged to be different is that one is superior to the other. However, only if natural ability has a quantitative nature, then one level of ability can be 30 or 32 times that of another, because if we assume that level a is 32 times that of level *b*, then $a = b + b + ... + b$ (so there are 32*bs* added together). This implies that natural ability attributes have an additive structure. In the second example, Galton (1869) considered the abilities of different "races." He stated, "From this it follows that the average ability of the Athenian race, at the lowest possible estimate, is nearly two orders of magnitude higher than ours — this is equivalent to the ability of our race being above that of the African Negro race." This statement also implies that Galton viewed natural ability as something that could be measured quantitatively because he compared the average ability between racial groups with concrete numbers, assuming the quantitative nature of this ability.

> “The assertion that levels of ability within a “race” have an average suggests that Galton considered ability to be a quantitative attribute. The average of a number of measurements can be calculated as the ratio between the number of those measurements and the number being measured, and this ratio exists only if the measured attribute has an additive structure. Attributes that do not have an additive structure, such as those that only have an order or ranking, cannot be measured, and therefore, do not have a computable average. Thus, Galton implied that ability is a quantitative attribute because it can have a calculable average.”

A third example is when Galton (1869) noted that measurements of physical traits in a sample of “Frenchmen” and “Scots” could be used to estimate the law of deviation from the mean, now known as the normal curve. Galton stated that if this law applies to height, then the same applies to all other physical characteristics, including head circumference, brain size, weight of gray matter, number of brain fibers, and so on. With this step, Galton indicated that the idea of quantitative attributes applies to various aspects, including mental capacity, and this became the basis for his approach to understanding natural abilities and their measurement.

Galton (1869) concluded that mental capacity, or natural ability, is approximately normally distributed in national populations. This kind of conclusion is only valid if ability is considered as a continuous quantitative attribute. In contrast, attributes that only have an order or ranking cannot maintain a normal distribution or a continuous mathematical distribution form. In other words, the idea that ability can follow a normal distribution is additional evidence that Galton viewed ability as something that can be measured quantitatively and has continuous properties. In the context of continuity, Galton (1869) stated, there is a continuity in the natural faculty which reaches from one who does not know how high, and descends to one who cannot know how deep. Although the term "continuity" used by Galton may refer to the more general sense of continuity known as order density, its use suggests that he was thinking analogously to quantitative attributes in physics, which are also continuous in both senses. Thus, Galton considered natural ability as an attribute that has continuity or continuity that includes various levels and variations, from the lowest to the highest. There is a striking difference between the data he uses and his quantitative assumptions. The data he used simply consisted of a list of individuals considered superior and their achievements in Cambridge examinations. Even by assigning an index of natural abilities to these data, nothing can imply that these abilities are attributes that simply have an order or ranking. The same applies to the concept of natural ability, as defined by Galton (1869):

> "By natural ability I mean the quality of intelligence and character which drives and is capable of qualifying a person to perform actions that bring reputation. I do not mean capacity without enthusiasm, or enthusiasm without capacity, or even a combination of both, without sufficient energy to carry out a lot of toilsome work. I mean the nature which, if allowed to develop freely, would be impelled by an innate drive to achieve excellence, and have the power to reach its peak. This is the nature which, if hindered or hampered, would feel restless and struggle against these obstacles until they are overcome, and this individual can return to following his instincts which tend to work hard. Doubt that such individuals will generally achieve prominent positions is a contradiction in terms. Moreover, the evidence to be found in this book shows that few people do managed to achieve a high reputation without having this special talent. Therefore, those who achieve excellence and those who possess this natural ability are, for the most part, one and the same.”

In this explanation, Galton describes natural ability as a unique combination of intelligence, character, enthusiasm, and capacity that drives a person to achieve excellence. He believed that individuals with these natural abilities tended to achieve prominent positions in society. Galton (1869) recognized that there was more than one varying level of ability, and he emphasized that the previously described levels were considered necessary and sufficient criteria for achieving excellence, which was his focus. The three components he mentioned, namely intellectual ability, enthusiasm, and the ability to work hard, are dispositional concepts. This concept describes the characteristics of natural abilities indirectly through individual behavior. It is important to note that this is not a scientific definition that explicitly legitimizes excellence as a representation of genius, but rather represents an initial attempt at understanding the attributes that might help individuals achieve high achievement. Although each of the three components supports a greater or lesser relationship, none supports a numerical comparison. That is, if someone has greater intellectual ability, greater enthusiasm, or a greater capacity for hard work than another person, the meaning is clear. However, if we state that someone's intellectual ability is r times that of another person, or that they have s times the passion, or t times the capacity for hard work (where r, s, and t are any positive real numbers), then the meaning becomes unclear. However, in the context of quantitative attributes, numerical comparisons have a clear meaning and can be understood transparently. Thus, quantitative structure is not an integral part of these components. To assume that natural ability is a

continuous quantitative attribute analogous to the attributes measured in physics is to cross the line in two respects. First, Galton lacked sufficient evidence to support this view. Second, given his focus on the heritability of genius, Galton actually only required binary ordered attributes, for example, genius and non-genius. Therefore, this assumption is not only unjustified, but also unnecessary. Fifteen years later, clues about the reasons behind this view are starting to emerge.

d. Relevance for Psychometrics

Michell (2022) is relevant to the field of psychometrics because it critically examines the quantitative presuppositions that have shaped the development of the discipline. The article highlights the historical origins of this presupposition in the ideas of Francis Galton and argues for its validity. Criticism of quantitative presuppositions has implications for psychometric methods and practice, challenging the assumption that mental attributes are inherently quantitative and can be measured using numerical scales and statistical methods. Michell (2022) argues for a more comprehensive and nuanced understanding of measurement in psychometrics, which includes qualitative approaches, subjective interpretations, and consideration of contextual and subjective aspects of mental attributes. This article calls for a reevaluation of the dominant quantitative paradigm in psychometrics and greater recognition of the limitations and complexity of measuring mental attributes. Overall, this article contributes to the ongoing discussion and debate in the field of psychometrics regarding the nature of measurement, the role of qualitative approaches, and the need for a more holistic understanding of mental attributes.

4. Conclusion

Based Francis Galton played an important role in establishing the belief that mental attributes could be measured. Through psychometric experiments and the development of statistical methods, Galton attempted to measure and quantify various mental traits, ultimately laying the foundation for the field of psychometrics. Galton's work contributed to the belief that mental attributes such as intelligence could be measured empirically. Additionally, quantitative assumptions in psychometrics stemming from Galton's belief that mental attributes can be measured, had a significant influence on the development of this field. Psychometrics has been built on the assumption that mental attributes can be measured and interpreted using numerical scales and statistical methods. These assumptions shape psychometric methods and practice, including the construction of mental tests, the development of scoring systems, and the interpretation of test results.

However, there has been criticism of the quantitative assumptions in psychometrics. One criticism is that the theory is based on the erroneous assumption that all mental attributes have a quantitative structure, whereas mental attributes may have a qualitative or ordinal structure that cannot be fully captured by numerical measurements. Another criticism is that the focus on quantification ignores the qualitative aspects of mental attributes, thereby not capturing the complexity and subjective nuances of mental experience. Critics argue that psychometrics should adopt a more comprehensive and multidimensional approach that includes qualitative methods and considers contextual and subjective aspects of mental attributes. They advocate a broader understanding of measurement that goes beyond numerical quantification and includes qualitative assessment, narrative approaches, and subjective interpretation. Overall, although quantitative assumptions in psychometrics have shaped the field and its practice, there have also been criticisms that point to limitations in capturing the complexity and qualitative aspects of mental attributes. This suggests a need for a more holistic understanding in the measurement of mental attributes.

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