



# Quantities, Quantification, and the Necessary and Sufficient Conditions for Measurement <sup>☆</sup>



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## ARTICLE INFO

### Article history:

Received 12 July 2016

Received in revised form 8 December 2016

Accepted 26 December 2016

Available online 29 December 2016

### Keywords:

Measurement

Philosophy of measurement

Measure

Quantity

Quantification

Quantitative evaluation

## ABSTRACT

Although measurement has been an important component of human activities for millennia, it remains remarkably difficult to provide a fully satisfactory definition of the concept. In part this is due to the fact that measurement is a diverse and dynamic human activity, and takes shape in a wide variety of ways depending on the nature of the subject matter, application, and context. If a definition of measurement is to pay respect to this basic fact, it cannot be so narrowly construed as to apply to only one area of scientific activity (e.g., physics); on the other hand, the definition cannot be so permissive as to trivialize the concept to the point that measurement is not recognizably superior to, for instance, guesses or statements of opinion. One issue at the heart of this tension is the relationship between the concepts of measurement, quantity, and quantification. In particular, it is sometimes argued or assumed either that quantification is a necessary condition for measurement, or that quantification is simply synonymous with measurement. To assess the validity of these positions, the concepts of measurement, quantity, and quantification should be independently defined and their relationships analyzed. In this paper we conduct such an analysis, from both historical and philosophical perspectives, and present the case that quantification is neither necessary nor sufficient for measurement. We conclude by considering how the conceptual separation of measurement and quantification serves to promote more productive and shared understandings of measurement across disciplines.

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## 1. Introduction

Measurement is, and has been for some time, an integral component of a wide range of human activities, and is commonly afforded privileged status as a trustworthy source of knowledge. Measurement processes are now regularly encountered not only in increasingly diverse ways in the physical sciences and engineering, but also (especially within the past century) in the psychological sciences and social research. However, as the activities that demand precise and trustworthy information have diversified, the scope of activities conducted under the banner of measure-

ment has broadened [21], and it is not always obvious what all these ways of measuring have in common with one another.

Some current uses and understandings of measurement are largely motivated based on historical traditions of practice (see for example [26,32]), and therefore it is important to consider a historical perspective when approaching this topic. History helps us understand how the concept of measurement has evolved, and serves as a starting point for rethinking how we can best approach it in the future. We hold that any examination of the characteristics of measurement must be sensitive to how it is understood and used in diverse contexts, and how it adds value to a wide range of human activities. Thus, the task of locating the defining characteristics of measurement, independently of the specific subject matter or application—such that the definition “is broad as it can be without doing undue violence to either the ordinary meaning or the technical meaning of the term” [41, p. 158]—is not trivial.

<sup>☆</sup> One of the authors is a member of the Joint Committee for Guides in Metrology (JCGM) Working Group 2 (VIM). The opinion expressed in this paper does not necessarily represent the view of this Working Group.

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