

On Thinking (and Measurement)

RAYMOND AARON YOUNIS

School of Philosophy, University of Notre Dame (Sydney)

Abstract:

We do indeed “live and work in a time when the issues facing education, many of which have been with us for a considerable period, are being approached primarily through measurement – classroom assessment, research methods, standardized testing, international comparisons”. It is also true that “we do not often stop to consider what counts – and alternatively, what doesn’t count – in a climate where measuring up to a standard is the name of the game. At a deeper level, we rarely raise questions about measurement itself.”

*Heidegger argued that what is “most thought provoking [in this ‘thought provoking age’] is that we are still not thinking,” in *What is called thinking? (Was Heisst Denken? 1954, p.4)*. This somewhat startling assertion deserves careful attention especially in relation to the quote above (“we do not often stop to consider what counts – and alternatively, what doesn’t count – in a climate where measuring up to a standard is the name of the game”). Heidegger’s assertion is pertinent for a number of reasons: he associated this “not thinking” with a “critical moment in history”(p.57), with a “call”, and with a “miscalculation”. I will argue that it is important (again?) to reflect on a number of questions: what is thinking, especially in relation to measurement? Was Heidegger correct in arguing that we have “miscalculated” in so far as we have sought “the safety of the mere drive for calculation” (*The End of Philosophy, p. 106*)? And how does the desire for a higher form of “representational thinking” (in Heidegger’s words; *EOP, p. 110*) in these contexts serve and promote a number of aims in higher education, such as (“student-centred”) learning and even “flourishing”? I will attempt to provide answers to a number of these questions by reflecting on the broad but fundamentally important question of measurement and its limits.*

Keywords: thinking, measurement, calculative thinking, learning, evaluation

No doubt, there are different ways of understanding measurement (and its instruments, defined broadly). This is an important fact, not least because a focus on measurement, even a preoccupation with measurement, can be amplified into something far more thought-provoking, even alarming, if one thinks of Heidegger’s focus on “calculative thinking”- namely a kind of thinking which dominates and pervades all thinking, or thinking in general, about things that can be measured and by extension, even, that cannot be measured also. I will argue that some of Heidegger’s arguments concerning the dominance or paradigmatic nature of “calculative thinking” can be met by a careful and more nuanced understanding of the relationship between measurement (which in one sense, relies on calculation), and more broadly draws upon calculative reason, and even more broadly, on “calculative thinking” inasmuch as calculation comes to be seen as essential to an understanding of the meaning in and of things.

I will also argue that one can employ measurement in some senses, (and much more broadly, a kind of calculative thinking), for example in education, without necessarily abandoning meditative thought, a kind of pondering, or an opening for thinking that is not necessarily deleterious in terms of our nature as thinking beings, and without contributing to what Heidegger called “growing thoughtlessness” (1969, p.45; 1968, p.30; 1977, p.21). This claim is especially important when one thinks critically of the value of measurement, and indeed evaluation, in education.

The Question of Definition

The question of measurement, its nature and meaning, has been a topic of debate among many philosophers. Not surprisingly one finds a number of different definitions. Ernest Nagel (1963) understands measurement in terms of the “correlation with numbers of entities which are not numbers” (p.121). He argued that such a definition is “sufficiently comprehensive though cryptic”; he added, “the problems of measurement merge, at one end, with the problems of predication [what it means to be a “man” or a “circle”] (1963, p.121). He also believed that the *raison d’être* of “numbers in measurement is the elimination of ambiguity in classification and the achievement of uniformity in practice” (1963, p.122). S. S. Stevens understands measurement as “the assignment of numerals to things so as to represent facts and conventions about them” (1963, p.148) and adds that measurement

is never better than the empirical operations by which it is carried out, and operations range from bad to good. Any particular scale, sensory or physical, may be objected to on grounds of bias, low precision, restricted generality, and other factors, but the objector should remember that these are relative and practical matters and that no scale used by mortals is perfectly free of their taint. (1963, p.149)

Zoltan Domotor and Vadim Batitsky understand the measuring process as one which is “modeled by a physical interaction between the measured object instantiating the measurand and the measurand’s measuring instrument.” (2008, p.145) “Instrument” can presumably be understood here in a broad sense, for instance, in the form of a survey. They add: “the interaction is described by a state transformation of the compound system ‘object + instrument,’ in which the final state of the instrument completely determines the instrument quantity’s value that is then used to approximate the measurand’s value.” (2008, p.145)

Each of these definitions is helpful: Nagel’s definition highlights, quite properly, the relationship between numbers and things which are not numbers (for example, human subjects) and further, between subjects and things that may be predicated of them; the “elimination of ambiguity in classification and the achievement of uniformity in practice” does sound like an *ideal* of measurement, though, in the sense that it is difficult to see how all forms of measurement can always entail such outcomes. Stevens highlights such issues in his own definition, for example, and emphasises the relationship between numbers, things which are not numbers, and representations of those things (that is to say, conventions, facts and so on that are employed in order to make sense of these things). Given the imprecision of some instruments (including some surveys), and given the differences in interpretation that one sometimes finds (for example, in the interpretation of measurements in Quantum Mechanics) he is surely correct in also emphasising the possibility of bias, restricted generality, and such things, without forgetting the allied point - that “no scale used by mortals is perfectly free of their taint”. The last claim is a little difficult to justify since it is a broad (inductive) generalisation, but one could argue that is in all probability true of many, if not all, measurements that rely on scale.

Nagel does not miss or overlook such issues altogether, to be fair. He argues that a numerical measurement is “only one way of making evaluations of certain selected characters, although it is so far the best” (1963, p.122). It is the “best” presumably because it makes use of a “universally recognized language”; it makes possible a “refinement of analysis without loss of clarity”; it gives us an “emotionally neutral character and permits a symbolic rendering of invariant relations in a manifold of changing qualities” – in short it allows us to express a “recognition of a necessity which is not human” (1963, p.122). A number of points deserve careful attention here. Once again, Nagel seems to be describing measurement at an ideal level. For example, no “loss of clarity” may be true of the numbers themselves but it is difficult to see how an analysis can preserve entirely this kind of thing- that is to say an analysis which is not itself expressed in numerical form. So once again, a measurement may give us a value and that value in itself may be entirely clear; however it does not follow from this that an analysis of the meaning of that value, which is expressed in non-numerical form, will meet all these criteria (especially, no loss of clarity).

The physical interpretation itself, as he recognised, allows us to discover some properties of the world, since mathematics (and by extension measurement), “is relevant to the exploration of nature” (1963, p.123). (There is an important question here in terms of the “exploration of nature”, namely, that of the extent to which we can know this claim to be true, but that is an epistemological question that takes us beyond the immediate scope of this paper). That physical interpretation, he added, “will constitute whenever it can be found, the conditions for

the measurement of that subject matter.” (1963, p.123). He did recognise a number of limits like Stevens: he drew a distinction between “those qualities which are capable of fundamental measurement and those which are not” (1963, p.135); measurement is understood in this light as the concerted attempt to “obtain well-defined connections, expressed mathematically wherever possible, between qualities measured or measurable fundamentally and those incapable of such measurement.” (1963, p.135). He also recognised the importance of some loss of clarity, especially when a confusion arises:

it is a great sin to *compare* the statement of a relation with the relation itself.... the equation, in every case, is a symbolic statement, pointing to several aspects of the subject matter. When once the plural referents of the symbols are made explicit, and when numbers are not regarded either as common qualities or as chaste platonic beings, but rather as the expression of relations or operations between qualities, belief in the power and validity of mathematical physics need not be superstition (1963, p.139).

The point is well made, though some questions arise here also: for example, it is not clear if the “plural referents of the symbols” can be made explicit, systematically or consistently, in an entirely clear or unambiguous way. This is not to deny the kind of power and validity that Nagel is affirming here; the point is that the criterion concerning clarity may be very difficult to meet on occasions, especially when it is not the relation itself that is at issue, but rather the statement of a relation, and by extension, the understanding of its meaning. (One might think here of the relation that holds between energy and matter broadly conceived, and then consider the *statement and the meaning* of the further relation between dark energy and dark matter.)

Robert Crease adds considerably to this picture. He distinguishes between two kinds of measuring: “ontic” measuring, which is concerned with objects or the properties of objects; and measuring which does not “involve placing something alongside a stick or on a scale”, namely, “fitting” (“less an act than an experience: we sense that things don’t ‘measure up’ to what they could be). (2011, n.p.) This second kind of measuring, “ontological measuring”, refers to the use of good examples (such as Aristotle’s “measure” of a good person) that might help to clarify our understanding of what something is; it highlights “how something exists”. (2011, n.p.) Crease adds: the “distinction between the two ways of measuring is often overlooked, sometimes with disastrous results”. (2011, n.p.)

Heidegger and the Limits of Calculative Thinking

Certainly the disastrous, or potentially disastrous, results of confusing or misunderstanding certain kinds of measurement, or measuring activities, are emphasised in the work of Martin Heidegger. Heidegger was writing a number of important reflections on a certain kind of thinking at more or less the same time as Nagel and Stevens. Whereas Nagel, Stevens and others were emphasising the power and validity of measurement (and the sort of thinking and form of explanations that underpin it), Heidegger was voicing concerns increasingly about a transformation in our thinking about the world that could conceivably have catastrophic consequences. He explored this in a number of important works.

In *Discourse on Thinking* (1969) he writes:

the growing thoughtlessness must, therefore, spring from some process that gnaws at the very marrow of man today: man today is in flight from thinking. This flight-from-thought is the ground of thoughtlessness. But part of this flight is that man will neither see nor admit it. Man today will even flatly deny this flight from thinking. He will assert the opposite. He will say – and quite rightly – that there were at no time such far-reaching plans, so many inquiries in so many areas, research carried on as passionately today. Of course. And this display of ingenuity and deliberation has its own great usefulness. Such thought remains indispensable. But – it also remains true that it is thinking of a special kind (1969, pp. 45-46)

The claim is a striking one, and it is not altogether clear. The “flight” from thinking could mean that it is an escape from this kind of thinking, in the sense, perhaps, that it is an attempt to flee collectively from a kind of

thinking which is not easy or which does not have some kind of utility; or it could mean that it is a kind of forgetting (and certainly, “forgetting” is an important theme in his early and late works), amongst other things. Notwithstanding this ambiguity, it is identified as the “ground of thoughtlessness” which may mean that it is at the basis of the problem of forgetting or of escape, or it is the fundamental cause of the “flight”. If it is at the basis or if it is the cause of the problem then it would be conceivable that a type of thinking that is focussed on utility or on usefulness might miss such things altogether and even in this context, deny that such a thing is happening, since “so many inquiries” and so much research are taking place. Heidegger grants that this kind of thinking, that is, ingenuity and deliberation, for example, attuned to things such as utility, and indeed measurement as a utilitarian instrument, so to speak (no pun intended!), “remains indispensable”. But he goes much further than this:

Wherever we plan, research and organize... we take them [conditions that are given] into account with the calculated intention of their serving specific purposes. Thus we can count on specific results. This calculation is the mark of all thinking that plans and investigates.... Calculative thinking computes.... Ever anew, ever more promising and at the same time more economical possibilities... [it] races from one prospect to the next.... Never stops, never collects itself... [it] is not meditative thinking, not thinking which contemplates the meaning which reigns in everything that is. (1969, p.46)

In so far as measurement, or rather, the thinking that is conditioned by measurement and by the presupposition that things that are measurable are of the essence, one might say, “reigns”, then we can “count on specific results”; specific outcomes; by extension, a certain kind of utility. These are some of the distinguishing marks of “calculative thinking”; it encompasses planning, measuring, this kind of “investigation”; it processes information; it is reiterated; it unfolds in all of its forms even as this type of thinking forgets, escapes from, or ceases to be conscious of the things that bind it and unify it at its foundations, perhaps because its foundations have become obscured or concealed by the drive towards “investigation” for the purpose of maximal utilitarian outcomes or, as a subset (itself a kind of calculative term), “economic possibilities”.

Heidegger reminds us, in this striking, somewhat elusive but unforgettable passage, if we need to be reminded, that this kind of thinking, once it becomes dominant, or *paradigmatic*, if you like, obscures, conceals and even displaces another kind of thinking, one that philosophy traditionally vouchsafes and preserves (especially in ancient Greek ontology), that thinking which is concerned perennially with meaning more broadly, with things that are genuinely meaningful more broadly, that is, with the “meaning which reigns in everything that is”. Once again this is striking but a little unclear.

“Meaning” here might mean significance or value or something like that. Notwithstanding such complaints, “meditative thinking” is not “calculative thinking” because it contemplates “meaning” which “reigns” ontologically, and in the broadest contexts, that is to say, not merely on an instrumental or utilitarian or economical plane. It is in this context, according to Heidegger, that “meditative thinking” is seen to “lose touch”; to be “worthless for dealing with current business” or “practical affairs” (1969, p.46) – a potentially catastrophic set of assumptions and affirmations, since it leads according to Heidegger to a startling claim: we find ourselves “suddenly and unaware...firmly shackled to these technical devices that we fall into bondage to them.... we can affirm the unavoidable use of technical devices, and also deny them the right to dominate us, and so to warp confuse, and lay waste our nature. (1969, pp. 53-54).

In the same way that the “flourishing of any genuine work” depends “upon its roots in a native soil” (1969, p. 47) so too, it would seem, does “calculative thinking” lead away from flourishing since, by this analogy, it leads away, in terms of “flight”, from its own “native “soil”, or from thinking that concerns itself with the ground, with ontological thinking of a primordial kind, attuned to its foundation, and which recalls the “meaning which reigns in everything that is”. (1969, p.46). He asks: “will everything now fall into the clutches of planning and calculation, of organization and automation?” (1969, p.49). Other questions arise: will we forget to ponder or forget even to ask the questions that lead us back to this kind of thinking? (1969, p.50). Will the world “now appear as an object open to the attacks of calculative thought, attacks that nothing is believed able any longer to resist”? (1969, p. 50) What is “uncanny” then is not that the world grasped through “calculative thinking” is

becoming “entirely technical” but rather that we are in “unprepared for this transformation” perhaps because we do not ponder things deeply enough or because we have forgotten foundational questions about the meaning of things and their relation, essentially, to their ground (ontologically speaking); what is “uncanny” is just this “inability to confront meditatively what is really dawning in this age” (1969, p.52).

He had no doubt that a

profound change is taking place in man’s relation to nature and to the world [and to human nature]. But the meaning that reigns in this change remains obscure.... *the meaning pervading technology hides itself...* the comportment which enables us to keep open to the meaning hidden in technology [is] *openness to the mystery...* a new ground and foundation upon which we can stand and endure in the world of technology without being imperiled by it. (1969, p.55).

It seems he is arguing that “calculative thinking” has become so pervasive, so paradigmatic, that we have largely become, or we have (almost?) entirely become – the meaning is not very clear here, it must be said – oblivious of the fact that it is functioning in this way, that is, in a way that obliterates alternative deeper (ontological, not merely instrumental) ways of thinking and seeing. He reinforces this point with another startling metaphor that is not so unclear: the “approaching tide of technological revolution in the atomic age could so captivate, bewitch, dazzle, and beguile man that calculative thinking may someday come to be accepted and practiced *as the only way* of thinking...” (1969, p.56) – hyperbole, perhaps, but nonetheless, it should be said that the threat of the dominance of this kind of paradigm, at the expense of profound alternatives, should awaken some concern, if not the sort of alarm that Heidegger’s writings in this key suggest.

What great danger then might move upon us? Then there might go hand in hand with the greatest ingenuity in calculative thinking an inventing indifference toward meditative thinking, total thoughtlessness. And then? Then man would have denied and thrown away his own special nature – that he is a meditative being. Therefore, the issue is the saving of man’s essential nature. Therefore, the issue is keeping meditative thinking alive... persistent courageous thinking... (1969, p. 56).

Heidegger’s argument relies on a number of leaps here: from the claim that “calculative thinking” is dominant or even pervasive or paradigmatic, to “total thoughtlessness”, which even if charitably interpreted, it must be said, looks rather hyperbolic. Even if this kind of thinking is dominant, it does not follow that it “reigns” everywhere. Nor does it follow that from the dominance of this kind of thinking in general, we must have sacrificed or in some sense lost “man’s essential nature”, even if that nature is in part associated with “meditative thinking”; even if most people privilege “calculative thinking”, it would not necessarily imply that we have “thrown away” our “special nature” as human beings. It would take just one person to think meditatively in order for us to claim that “man’s essential nature” in this respect has not been “thrown away” or obliterated, in so far as that nature is being manifested in the thinking that is then taking place. Moreover, it would take the existence of the possibility of thinking otherwise, especially in meditative ways, to allow one to claim that our “special nature” as meditative beings remains intact, to some extent at least.

Our “nature”, on this interpretation, as meditative beings, is not just a question of how we think, why we think and what we think; it goes to the heart of what is possible, what remains in us at the level of potentiality. If these claims are correct then it would follow that “man’s essential nature” is not necessarily in need of saving, for as long as there are some thinkers (like Heidegger for instance), or for as long as there are a few thinkers who still think meditatively, or in whom the potential for this kind of thinking is preserved. In cases such as this, “man’s essential nature” inasmuch as it is comprised by meditative thinking, would not necessarily be in need of saving, even if the “coldness of calculation” “reigns” generally (but not absolutely) and even if reason is, in general, “attuned to confidence in the logically mathematical intelligence of its principles and rules” (1956, p. 91). There remains the possibility that knowledge, and inquiry, may be other than “calculation” and other than the “sign of the degradation of thinking” or as the “elevation of logistics to the rank of true logic” (“logistics” is understood by Heidegger as the “calculable organization of the unconditional lack of knowledge about the essence of thinking”) (2003, p.80).

Concluding reflections

It is important to bear in mind the kind of measurement one is talking about and the kinds of things that one is trying to measure. For example, if the measuring instrument is a survey and if one wishes to measure the perceptions of students on a particular course or class in which student-centred learning is the paradigm, then this can be done, if not with complete precision, then certainly in a way that might produce meaningful results, that is, results that one could act upon. It would be possible to find out what students value, for example, and what they do not, and even if complete clarity or precision is not achievable, nonetheless it would be rash to conclude that we are not necessarily thinking well or deeply, in this kind of context.

Heidegger's argument, namely that "measurement" in general or measurement fundamentally is problematic because it is based on "calculative thinking" is an important but in some respects a limited insight. If "meditative thinking" is the alternative we ought to pursue, then the meaning that "reigns in everything that is" becomes the focus. But it may be asked here to what extent thinking – whether calculative or meditative – is adequate to this great task, especially given the work of Kant and Hume and many who come after, on the limits of reason, experience and more broadly, thinking (Heidegger, 1997, pp. 170-175). It is at the very least conceivable that "meditative thinking" may not take us all the way, so to speak, towards such an encompassing understanding of "meaning".

Nonetheless, in terms of education and measurement, the use of calculation, may produce important insights and meaningful results. What a neo-Heideggerian approach would highlight here is that it is important that such measurement, such uses of calculation (for example, in a statistical sense, working out means, medians and modes) should not come to be seen as the only way of thinking or as the definitive ways of thinking about things – as being of the essence.

So if we are concerned with something like student-centred learning, its limits and efficacy, we ought to make measurement a part of our analysis, perhaps, without privileging it as the only way or as the essential way of reaching a deep and encompassing understanding of such things; certainly, if Heidegger is correct, without *assuming* (and this is a crucial term here) that we are gaining an understanding of all students, or of student-centred learning as a whole, that is, an understanding that is of the essence.

But why should we come to see it in this way, that is, as being of the essence? It certainly does not follow: it is at least conceivable that an instrument of measurement may be employed with a sophisticated sense of its limitations (again, one might think of much work here on the limits of statistics and statistical sampling) or with a sharp sense of the limitations that apply to questions that are asked, answers that are given, and the data to be collected, for example, about student perceptions and student feedback. In other words, it would not follow from the activities of measurement or even an emphasis on measurement that one has forgotten or is in flight from "meditative thinking" (or from alternatives to "calculative thinking"). The inherent limitations of the instruments themselves may indeed be part of the debate, in quite a rational and sophisticated way.

It is conceivable too that one might learn something profound about the nature of instruments and the nature of calculation, and these insights may conceivably also inform our understanding of the meaning that "reigns" in things which are in fact calculable or measurable, without losing sight of things that go well beyond these limited approaches and frameworks. In short it is important to allow, in this neo-Heideggerian context, when speaking of measurement or more broadly of "calculative thinking", that the meaning of the things that we are studying may be studied in other ways and in terms of a different way of thinking. A calculative approach, which is modest and not absolute would not necessarily "lay waste our nature" so long as one grants that there are inherent limitations in instruments and consequent acts of measurement and so long as one is aware of valid alternative ways of thinking about the very same things.

Of course, Heidegger might have responded by arguing that we would be missing the essence, where "essence" means those things that endure in us, and that we cannot have a deep understanding of things when what is measured or measurable is privileged or becomes paradigmatic of progress, everywhere or in general. Nonetheless it does seem clear that we can understand some things, such as student perceptions of excellence in

a course or in classes, or more broadly in education, without necessarily commanding an understanding, meditatively, of meaning in a more encompassing sense. And it is possible to understand these kinds of things well without necessarily being dogmatic about meaning and measurement; that is, for example, by recalling the limits and boundaries of these kinds of measurements and this kind of thinking. In other words, there would be no contradiction necessarily between this kind of recollection and an ongoing affirmation of the power and profundity of “meditative thinking”. Indeed, the recollection in just this context, could be conditioned by the power of “meditative thinking”, the paths it opens up in relation to our understanding of numbers, relations, and statements of relations, ways of understanding these, and indeed, their limits. This kind of thing can conceivably allow us, in a sense, to “confront meditatively what is really dawning in this age” (1969, p.52), if Heidegger is correct about the dawning of “calculative thinking” (in the modern age) which relies excessively on measurement and instrumental value, and other such things. It could conceivably allow us to question, to think through more deeply, those attacks “that nothing is believed any longer to resist” (1969, p.50); this could constitute a resistance, and one might argue (though this is a topic for another time), that this kind of resistance is taking place and ought to continue to do so.

In order to understand measurement and that which is measurable deeply, one might argue that it is important to understand measurement in the light of its nature, meaning, significance and range of application. It is important to understand things in the light of their nature, meaning, significance and range of application, but also in the light of relevant limits and boundaries (to the measurable, the calculable, the thinkable). In this kind of way, we can open up an understanding of measurement, without necessarily being captivated or bewitched or dominated by numbers, relations between numbers, statements of relations and ways of understanding all of these, and without coming to think that this is the only way of understanding these things. Then it would be possible to keep open a path to a deeper understanding of the conditions of possibility and the meaning of other things which might conceivably transcend such limits and boundaries. In Heidegger’s words, within that kind of framework, open to the possibility of thinking more deeply and even thinking otherwise, in “that ground, the creativity which produces lasting works could strike new roots.” (1966, p.57)

Bibliography

- Batitsky, V. (1998). Empiricism and the myth of fundamental measurement. *Synthese*, 51-73.
- Batitsky, V., & Domotor, Z. (2007). When good theories make bad predictions. *Synthese*, 79-103.
- Crease, R. (2011). Measurement and Its Discontents. Retrieved from http://www.nytimes.com/2011/10/23/opinion/sunday/measurement-and-its-discontents.html?_r=0
- Domotor, Zoltan & Batitsky, Vadim. (2008). The Analytic Versus Representational Theory of Measurement: A Philosophy of Science Perspective. *Measurement Science Review*, Volume 8, Section 1, No. 6, 129-146.
- Heidegger, Martin. (1956). *What is Philosophy?* (J. T. Wilde & W. Kluback, Trans.). New Haven, Conn.: College & University Press.
- Heidegger, Martin. (1966). *Discourse on Thinking*. (J. M. Anderson & H. Freund, Trans.). New York: Harper & Row
- Heidegger, Martin. (1968). *What is Called Thinking?* (J. Glenn Gray, Trans.). New York: Harper Colophon Books.
- Heidegger, Martin. (1977). *The Question Concerning Technology & Other Essays*. (W. Lovitt, Trans.). New York: Harper Torchbooks
- Heidegger, Martin. (1987). *WIntroduction to Metaphysics* (Ralph Manheim, Trans.). New Haven: Yale university Press.
- Heidegger, Martin. (1991). *The Principle of Reason*. (R. Lilly, Trans.). Bloomington & Indianapolis: Indiana University Press.
- Heidegger, Martin. (1993). *Basic Concepts* (G. E. Aylesworth, Trans.). Bloomington & Inadianapolis: Indiana University Press.
- Heidegger, Martin. (1997). *Kant & the Problem of Metaphysics* (R. Taft, Trans.). Bloomington & Inadianapolis: Indiana University Press.
- Heidegger, Martin. (2002). *The Essence of Truth* (Ted Sadler, Trans.) New York: Continuum.
- Heidegger, Martin. (2003). *The End of Philosophy*. (J. Stambaugh, Trans.). Chicago: The University of Chicago Press.
- Luce, D., & Marley, A.A.J. (1969). This is a chapter. Extensive measurement when concatenation is restricted and maximal elements may exist. In S. Morgenbesser, P. Suppes, & M. White (Eds.), *Philosophy, Science, and Method: Essays in Honor of Ernest Nagel* (pp.235-249). New York: St. Martin Press.
- Nagel, Ernest. (1963). This is a chapter. "Measurement". In Arthur Danto & Sidney Morgenbesser (Eds.), *Philosophy of Science* (pp. 121-140). New York: Meridian Books.
- Stevens, S.S. (1951). *Handbook of experimental psychology*. Oxford: Wiley.
- Stevens, S.S. (1963). This is a chapter. "On the theory of scales of measurement". In Arthur Danto & Sidney Morgenbesser (Eds.), *Philosophy of Science* (pp. 141-150). New York: Meridian Books.