# Vindicating Methodological Triangulation

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**Abstract**

Social scientists use many different methods, and there are often substantial disagreements about which method is appropriate for a given research question. A proponent of methodological triangulation believes that if multiple methods yield the same answer that answer is confirmed more strongly than it could have been by any single method. Methodological purists, on the other hand, believe that one should choose a single appropriate method and stick with it. Using formal tools from voting theory, we show that triangulation is more likely to lead to the correct answer than purism, assuming the scientist is subject to some degree of diffidence about the relative merits of the various methods. This is true even when in fact only one of the methods is appropriate for the given research question.

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## 1 Introduction

Methodological pluralism is an entrenched fact of life for the working social scientist. There exist a variety of different methods of carrying out social scientific work which are actually applied in the course of various research projects. While the contrast between quantitative and qualitative methods is the most striking, depending on how one individuates methods one can find methodological difference within as well as between those categories. For instance, ethnographic participant observation and hermeneutic textual analysis are distinct yet equally qualitative methods, whereas Bayesian and frequentist statistics provide different methods of running quantitive analysis.

It is not clear whether the fact of methodological pluralism is beneficial to social science. One optimistic response is to consider strategies for exploiting methodological pluralism to bolster the reliability of results obtained in the social sciences. To advocate this is to advocate what has come to be called "methodological triangulation". The idea behind methodological triangulation is that the convergence of multiple methods upon a single conclusion better supports that conclusion than just one of those methods arriving at the conclusion. Against this, however, pessimists might think that methodological pluralism is both a result and a source of confusion in the social sciences, and thus be unmoved by the advocacy of triangulation. After all, somebody who deduces that $2 + 2 = 4$ need not have their confidence bolstered by the fact that somebody who says that the sum of any two numbers is 4 has converged on the same answer as them in this case. Nor should they be concerned by their lack of triangulation with the person who always says "5". To somebody who sees methodological pluralism as arising from widespread methodological error, quite why methodological triangulation should be beneficial may thus remain opaque.

There is indeed a persistent vein of scepticism about methodological triangulation running through the literature. A class of theorists we term "methodological purists" argue that in order to understand any given phenomenon there is one method that should be used at the exclusion of others

(McEvoy and Richards 2006, p. 68). There are, typically, two sorts of arguments for this. The first is that different methods are often based on such wildly different presuppositions that any attempt to combine them can only lead to mischief or confusion. Kelle summarised this view as follows: "[r]esearch methods are often developed within differing research traditions carrying varying epistemological and theoretical assumptions with them. Thus the combination of methods... [will] not lead to more valid results" (Kelle 2005, p. 99; see also Blaikie 1991, p. 115, and Sim and Sharp 1998, p. 27). Sim and Sharp (1998, p. 26) claim that to avoid issues such as this one would have to decide in favour of one method and its accompanying theory. Since the fact of methodological pluralism in the social sciences is partially the result of theorists being unable to decide which paradigm to adopt, this would not bode well for methodological triangulation. The second sort of argument rests upon the sheer difficulty of actually simultaneously running multiple methodologies (cf. Farmer et al. 2006). This has led some to go so far as to argue that "using several different methods can actually increase the chance of error" (Kelle 2005, p. 99), since overtaxed scholars will be more haphazard in their work.

Note that another motivation for methodological purism would be the conviction that one's favoured method is simply epistemically superior, or, at least, epistemically superior when applied to some particular class of problems. Of course, while that may motivate methodological purism, it is unlikely by itself to persuade those of different methodological predilections. Hence, although it may motivate many, one rarely finds the conviction expressed in so naked a form in the literature. That said, it is not difficult to find works by partisans of qualitative versus quantitative methodology, or vice versa, in which they argue for their preferred style of research (see Bryman 1984 for a review and Tewksbury 2009 for a recent example). Hence it is worth explicitly noting this source of support for methodological purism, as sheer preference for one method over another is plausibly what motivates many in their methodological purism. Against this, we shall argue that the recognition that one method is superior should not by itself motivate methodological purism.

In order to respond to this scepticism about the merits of triangulation we outline a formal model of methodological triangulation in §2. This model is designed to be maximally generous to the opponent of methodological triangulation. Within our model there are multiple methods being run simultaneously to ascertain which of several propositions ought to be believed. We then show that under a variety of scenarios favourable to the purist, including scenarios more pessimistic in their appraisal of rival methods than any actual purists are likely to countenance, methodological triangulation still provides a good guide to truth providing one exhibits what we call Du Boisian diffidence, as discussed below. That is to say, there are reasons for an observer of a process of inquiry who is not sure which method to trust to none the less assent to the proposition which has been endorsed by multiple methods. The formal tools we use for this investigation are borrowed from voting theory, and more particularly the literature surrounding Condorcet's Jury Theorem (Grofman et al. 1983, List and Goodin 2001). We rely on some existing results and prove some new ones. We conclude in §3 by suggesting lines of future research.

There have long been practicing social scientists who have thought that methodological pluralism was an exploitable resource. In perhaps the earliest example of a scholar advocating methodological triangulation (Wortham 2005), writing in the 1890s Du Bois claimed that pluralism could be exploited to overcome the fact that "the methods of social research are at present so liable to inaccuracies that the careful student discloses the results of individual research with diffidence" (Du Bois 1996 [1899], p. 2). We therefore say that a scholar is in a state of *Du Boisian diffidence* just in case they are not confident which of various competing methodologies to trust. Although Du Bois did not outline why this should be, he thought that the use of multiple methods to study the same problem "may perhaps have corrected to some extent the errors of each" (Du Bois 1996 [1899], p. 3). He hence proceeded to deploy methodological triangulation in his own work. We take ourselves to be providing the mathematical foundations for Du Bois' insight.

Other social scientists have followed Du Bois in making use of methodological triangulation in their work (e.g., Farrall et al. 1997, Cunningham et al. 2000, Mangan et al. 2004, Jack and Raturi 2006). Not only has triangulation been applied by social scientists, but there has also been much favourable explicit reflection on triangulation as a methodology in itself. Indeed, the literature now contains a multitude of types of "methodological triangulation", each with their own rationale (for review see Thurmond 2001). Hence, although triangulation has been criticised in ways we mentioned above, we are certainly not the first to argue that triangulation "allows researchers to be more confident of their results" (Jick 1979, p. 608). Except in so far as they explicitly deny the ability of triangulation to provide additional confirmatory support for a hypothesis, we do not consider our arguments in tension with these alternate accounts of the benefits of triangulation. We are open to the possibility that there are additional benefits to methodological triangulation.

The tradition of work closest to ours in defending methodological triangulation is that which has implicitly or explicitly appealed to confirmation theory. At least as far back as Hempel confirmation theorists have acknowledged that "the confirmation of a hypothesis depends not only on the quantity of the favorable evidence available, but also on its variety: the greater the variety, the stronger the resulting support" (Hempel 1966, p. 34). Further, while philosophers dispute the concept's precise meaning, some scholars who discuss Whewell's notion of "consilience" interpret this in line with the idea that triangulation increases confirmatory support (Laudan 1971, Fisch 1985, Snyder 2005; for application see Leung and van de Vijver 2008). More recently, Fredericks and Miller (1988, p. 350) argue that Carnappian confirmation theory explains how it is that triangulation upon a proposition serves to increase one's rational degree of confidence in that proposition. Risjord et al. (2001, 2002) have even argued in the other direction, using the phenomenon of methodological triangulation to support a coherentist theory of confirmation. However, despite the attention paid to the relationship between methodological triangulation and confirmation, our literature search did not reveal any formal demonstration that methodological triangulation serves to increase degree of confirmation. The results from our model therefore fill that gap in the literature.

# 2 The Model

We will introduce our model by way of an example. Suppose we were investigating the effects of housing policy on quality of life in a given urban locale. For simplicity's sake we assume there are four possible answers – Great, Good, Bad, Terrible. We also assume that one answer is in some (epistemic) sense superior to the others (call this the "correct" answer). In our example we will suppose the correct answer is Good.

Three purist scholars set out to investigate the matter – the ethnographer convinced that the only way to address the issue is ethnographic participant observation, the sociologist convinced that a well-structured survey analyzed by sophisticated statistical techniques, and the economist putting their faith in the construction and analysis of rational choice models of the policy and its effects.

First suppose that each of these methods has some positive connection with the correct answer. Say each method has, independently of the other methods, a 1/3 probability of yielding the answer Good, and only a 2/9 probability each for each of the other three answers.

Now we introduce a final actor into our show, the triangulator, who runs no investigation of her own, but adopts the strategy: pick whatever answer is triangulated upon, otherwise guess between any of the answers selected by at least one method. In this example, the triangulator has a 29/81 probability of getting the answer Good. Since $29/81 > 1/3$, the triangulator has a better chance of settling on the right answer than the purists.

It might be thought that this result is an artifact of the particular numbers we chose. Theorem 1 shows this suspicion to be mistaken. In order to state the theorem, we will need a little more notation.

Suppose there are $m$ methods $a_1, \ldots, a_m$ available to address a given question. The question has $n$ possible answers $b_1, \ldots, b_n$, one of which is "correct". Without loss of generality, suppose the correct answer is $b_1$.

Each method, independently from the others, yields upon application one answer it endorses (we will call this the answer "picked" by that method). A method picks answer $b_j$ with probability $r_j$. The positive connection to the correct answer is represented by the assumption that $r_1 > r_j$ for all $j \neq 1$. So any method is more likely to pick the correct answer than it is to pick any given incorrect answer.

A purist picks a single method and always believes the answer picked by that method to be the correct answer. By assumption, then, the purist's belief is correct with probability $r_1$. A triangulator looks at the answers picked by all the methods available to her, and believes the answer picked by the greatest number of methods to be the correct one (if multiple answers are tied for being picked the most times, she picks a random answer among the tied ones to believe). Let $p_j$ denote the probability that the triangulator ends up believing answer $b_j$.

**Theorem 1.** *$p_1 \geq r_1$ for all $n$ and $m$. The inequality is strict whenever $m \geq 3$ and $n \geq 2$. Moreover, $p_1$ is increasing in $m$.*

This is a slightly strengthened version of List and Goodin (2001, proposition 1). A proof is available from the authors upon request.

So not only does a triangulator do better than a purist, a triangulator with more methods available also does better than a triangulator with less methods available. In fact, as the number of methods increases, it becomes virtually certain that the triangulator will get it right: $p_1 \to 1$ as $m \to \infty$ (List and Goodin 2001, proposition 2).

The above result arguably captures what Du Bois had in mind. Each method yields some evidence. Perhaps this evidence is not particularly strong on its own, but taken together the various methods can support a conclusion quite strongly. However, from the purist's perspective it may seem that our analysis is rigged: we assumed that each method has some probabilistic connection to the correct answer, whereas in reality (according to the purist) only the purist's preferred method does. So let us now turn to that scenario.

As it turns out, suppose, ethnographic participant observation really is The One True Method, sure to give the correct answer (that the effects of housing policy are Good), and the other two methodologies are more or less glorified guesswork (probability 1/4 of yielding each of the four possible answers).

Note that "guesswork" is the weakest possible assumption we can make about a method, as it entails that the results of this method provides no information whatsoever. If we made the "weaker" assumption of a negative connection with the correct answer (probability less than 1/4 of yielding the answer Good) the method actually becomes more useful: an "anti-triangulator" could use such a method to determine which answers are likely to be incorrect. Since no opponent of triangulation has proposed using methods to knock out potential answers we assume guesswork is what they have in mind when they say other methods are bad.

In this case the triangulator has a 9/16 probability of settling on the answer Good. She is doing worse than the ethnographer (who gets the correct answer with probability 1) but better than the sociologist and the economist (who get the correct answer with probability 1/4).

What should we conclude from this? Obviously the triangulator is not doing as well as the ethnographer. So if we know that ethnography is The One True Method there is no reason to use methodological triangulation.

But if we are in a case of Du Boisian diffidence things are different. Even if we know that there is a true method and the other two are just guesswork, it is good to be a triangulator: the triangulator gets it right 9 out of 16 times, whereas guessing what the right method is and sticking with that one only gets it right 8 out of those same 16 times ($1 \cdot 1/3 + 1/4 \cdot 2/3 = 1/2$).

Here again one might worry that the result is a numerical artifact, but once again we can assuage this worry. Consider the same setup as before, except now there is a special $m+1$-st method (call it $a_0$) which always picks the correct answer (answer $b_1$), while the other $m$ methods pick any answer with probability $1/n$.

The purist chooses a method at random (this reflects Du Boisian diffidence: the purist does not know which method is The One True Method), i.e., each method is chosen with probability $1/(m+1)$. Then the purist believes whatever answer that method picks to be the correct one. The triangulator, as before, believes whatever answer is picked by the most methods (randomizing in case of ties). Let $p_j$ and $q_j$ denote the probabilities of believing answer $b_j$ for the triangulator and the purist respectively.

**Theorem 2.** *$p_1 \geq q_1$ for all $n$ and $m$. The inequality is strict whenever $m \geq 2$ and $n \geq 2$.*

This result and theorem 3 are proved in appendix A.

We believe the above scenario is the most favorable possible scenario for the methodological purist (and thus showing that methodological triangulation can be valuable in it is our strongest arguments in its favor), because it assumes that the purist's preferred method is as good as it could possibly be and the other methods are as bad as they could possibly be. But it might still be objected that it is unrealistic that The One True Method delivers the correct answer with probability 1.

So now consider a case in which ethnography (The One True Method) yields the answer Good with probability 1/3 (2/9 each for the other three possible answers) while the other methods are random (1/4 for each answer). In this case the triangulator gets the answer Good with probability 41/144. The triangulator does worse than the ethnographer ($41/144 < 1/3$) but better than the other two ($1/4 < 41/144$). Just as before, if a scientist is subject to Du Boisian diffidence triangulation is the way to go. In particular, triangulation does better than picking a method at random and being a purist about that method ($1/3 \cdot 1/3 + 1/4 \cdot 2/3 = 40/144 < 41/144$).

More generally, suppose that method $a_0$ picks answer $b_j$ with probability $r_j$ and assume that $r_1 > 1/n$ (so $a_0$ favors $b_1$ more than chance, although another answer might be favored even more). As before, the other methods pick randomly: any answer $b_j$ has a $1/n$ chance of being picked. $p_j$ and $q_j$ are defined as above.

**Theorem 3.** *$p_1 \geq q_1$ for all $n$ and $m$. The inequality is strict whenever $m \geq 2$ and $n \geq 2$.*

# 3 Conclusion

Some social scientists have attempted to exploit the fact of methodological pluralism by claiming that where triangulation can be achieved this provides more support for the point triangulated upon than any method considered individually could. Though confirmation theorists seemed generally sympathetic to the idea, and saw links between points of interest to them and methodological triangulation, there had never been an explicit demonstration of this point. Further, other social scientists expressed scepticism about the benefits of triangulation. Our model has vindicated individuals' use of methodological triangulation, and thus also the instincts of the confirmation theorists. In line with Du Bois' methodological advice, triangulation does provide confirmatory support — and, in particular, it does so even if one is not sure which of one's available methods can actually be relied upon. Since we were following Du Bois in this we take ourselves to have supplied underpinnings for what is actually at least some of the social scientific rationale for methodological triangulation. As Du Bois foresaw, a significant benefit of triangulation is that it allows researchers who do not know precisely which method to trust to more effectively converge on the truth by favouring those results which have been triangulated upon.

The net effect of our arguments is to give those scholars who feel some degree of Du Boisian diffidence about the available methods in the social sciences reason to be happy about the fact of methodological pluralism. The various epistemological and methodological battles which have wracked the social sciences need not be resolved before one can proceed. Nor need this be accepted as an unfortunate brute fact of life, acquiesced to only out of resignation at the short span of a human lifetime and the intractability of our differences. Rather, since the various proponents of various methods have made reasonable points, none of which can be simply dismissed, we find that the tolerance of methodological pluralism does the diffident individual benefit, by allowing them to exploit triangulation in order to better arrive at the truth. We accept that to those who feel no degree of diffidence, our arguments may be less moving. In particular, to those who feel that the one true method in the social sciences should be qualitative, these arguments may all seem question begging. Perhaps so. But in our experience some degree of Du Boisian diffidence is the typical state of the scholar, and thus we take our results to be of interest to a broad range of people.

There is still, however, plenty of work left to be done, and we end by suggesting two additional lines of research. First, one source of anti-confirmationist scepticism we have not addressed is the worry that there is widespread correlated error. Some argument against this possibility seems to be necessary before methodological triangulation can be taken to provide methodological support. We hope that now there is formal apparatus available to rigorously study the benefits of methodological triangulation, it is possible to explore the circumstances in which correlated error will undo the advantages of triangulation.

Second, our arguments were markedly about the benefits of methodological triangulation for the diffident individual. However, work in social epistemology implies that what may be a rational strategy for an individual inquirer to adopt may be disadvantageous for the community as a whole if generally adopted (Mayo-Wilson et al. 2011). Hence, while our model vindicates individuals in exploiting methodological triangulation, it is not yet an argument in favour of methodological triangulation – and, thus, the fact of methodological pluralism – being to the benefit of science as a whole. Future work in this field could thus profitably explore a game theoretic, or otherwise social, model of the operation of methodological triangulation. In either case, we hope the work we have done here shall provide a useful foundation for further work in the field.

# A Proofs

For ease of exposition, we prove our results in the terminology of voting theory. The methods are the voters and the possible answers to the research question are the candidates.

Consider elections of the following form: there are $n$ candidates $b_1, \dots, b_n$, and $m+1$ voters $a_1, \dots, a_m$, and $a_0$ (the reason we single out $a_0$ will be explained shortly). Formally, we can describe a vote as a function $v : \{a_1, \dots, a_m, a_0\} \to \{b_1, \dots, b_n\}$. Each vote $v$ induces a probability measure $\mu_v$ on the set of candidates defined as follows:

- $\mu_v(b_k) = 1$ iff $|v^{-1}(b_k)| > |v^{-1}(b_j)|$ whenever $j \neq k$, i.e. candidate $b_k$ receives the most votes outright.
- $\mu_v(b_k) = 1/\ell$ iff $|v^{-1}(b_k)| \geq |v^{-1}(b_j)|$ for every $1 \leq j \leq n$, and there are $\ell$ candidates, including $b_k$, who receive the maximum number of votes.

Additionally, we may suppose that $\nu$ is a probability measure on the space $X$ of all possible votes. We define the *overall probability* $p_k$ that $b_k$ wins to be the quantity:

$$\int_X \mu_v(b_k) d\nu = \sum_{v \in X} \mu_v(b_k)\nu(v)$$

We will consider the following two procedures for choosing a candidate using a vote:

1. Choose candidate $b_k$ with probability $p_k$ (i.e., choose the winner of the vote). This is the triangulator's procedure.

2. Choose a voter $y \in \{a_1, \ldots, a_m, a_0\}$ randomly and uniformly, then choose the candidate chosen by voter $y$, i.e., choose candidate $b_k$ with probability $\int_X \delta(b_k, v(y)) d\nu = \sum_{v \in X} \delta(b_k, v(y))\nu(v)$. This is the purist's procedure.

Here $\delta(a, b) = 1$ if $a = b$ and $\delta(a, b) = 0$ otherwise. We see that in procedure 2, we hire candidate $b_k$ with probability $q_k$ defined as follows:

$$q_k = \frac{1}{m+1} \sum_{0 \leq i \leq m} \sum_{v \in X} \delta(b_k, v(a_i))\nu(v)$$

**Lemma 4.** *Let $A_v$ be the random variable $|v^{-1}(b_1)|$. Then $q_1 = \mathbb{E}(A_v)/(m+1)$.*

*Proof.* For any fixed $v \in X$, we have

$$|v^{-1}(b_1)| = \sum_{0 \leq i \leq m} \delta(b_1, v(a_i)).$$

It follows that

$$\mathbb{E}(A_v) = \sum_{v \in X} \sum_{0 \leq i \leq m} \delta(b_1, a_i)\nu(v). \qquad \square$$

We now focus on the special case where $a_0$ votes for $b_1$ and $a_1, \ldots, a_m$ vote randomly, uniformly, and independently. Set $Y = \{v \in X : v(a_0) = b_1\}$.

**Lemma 5.** *Let $B_v$ be the random variable* $\max(|v^{-1}(b_j)| : 1 \leq j \leq n)$. *Additionally, assume that $\nu$ is supported on $Y$ and uniform on $Y$. Then $p_1 = \mathbb{E}(B_v)/(m+1)$.*

*Proof.* Fix a vote $v$. Notice first that

$$B_v = \sum_{0 \leq i \leq m} \mu_v(v(a_i)).$$

Now the assumption that $\nu$ is uniform is equivalent to asserting that voter $a_0$ votes for $b_1$ while voters $a_1, \ldots, a_k$ each pick a candidate randomly, uniformly, and independently. In particular, we have for any $0 \leq i \leq m$ that

$$p_1 = \sum_{v \in Y} \mu_v(v(a_0))\nu(v) = \sum_{v \in Y} \mu_v(v(a_i))\nu(v). \qquad \square$$

*Remark.* Note that $\mathbb{E}(B_v)$ is the same for any $\nu$ where voters $a_1, \ldots, a_m$ vote randomly, uniformly, and independently; we will use this later to consider changing the manner in which $a_0$ votes.

**Theorem 2.** *If $\nu$ is supported on $Y$ and uniform on $Y$, then $p_1 \geq q_1$. The inequality is strict whenever $m \geq 2$ and $n \geq 2$.*

*Proof.* The first assertion is immediate from Lemmas 4 and 5 as $B_v \geq A_v$. If $m \geq 2$ and $n \geq 2$, there is some $v \in Y$ with $B_v > A_v$ (any vote where there is some outright winner who is not $b_1$ works). $\square$

*Remark.* Notice that in the setting of Theorem 2, we have $q_1 = (m + n)/(n(m+1))$. In particular, for any $\nu$ in which $a_1, \ldots, a_m$ vote randomly, uniformly, and independently, we have $\mathbb{E}(B_v) \geq (m+n)/n$, with strict inequality for $m, n \geq 2$. We will use this in the proof of Theorem 3.

We now prove the same result for $\nu$ in which $a_0$ votes for $b_i$ with probability $r_i$, where $r_1 > 1/n$.

**Theorem 3.** *Suppose $\nu$ is a measure where $a_1, \ldots, a_m$ vote randomly, uniformly, and independently (and independently of $a_0$), and suppose $a_0$ votes for $b_i$ with probability $r_i$, where $r_1 > 1/n$. Then $p_1 \geq q_1$, with strict inequality whenever $m, n \geq 2$.*

*Proof.* In the proof of Lemma 5 (and in the remark after), we saw that the probability that $a_0$ votes for the winner of $v$ is exactly $\mathbb{E}(B_v)/(m+1)$. So to compute $p_1$ in terms of $\mathbb{E}(B_v)$, we need to consider two cases: if $a_0$ does vote for $b_1$, we want to count the probability that $a_0$ voted for the winner, whereas if $a_0$ votes for $b_2, \ldots, b_n$, we want to count the probability that $a_0$ does not vote for the winner *and* that $b_1$ did in fact win. We see that:

$$
\begin{aligned}
p_1 &= r_1 \left( \frac{\mathbb{E}(B_v)}{m+1} \right) + (1 - r_1) \left( \frac{m + 1 - \mathbb{E}(B_v)}{(m+1)(n-1)} \right) \\
&= r_1 \left( \frac{\mathbb{E}(B_v)(n-1)}{(m+1)(n-1)} \right) + (1 - r_1) \left( \frac{m + 1 - \mathbb{E}(B_v)}{(m+1)(n-1)} \right) \\
&= \frac{(1 - r_1)(m+1) + \mathbb{E}(B_v)(r_1 n - 1)}{(m+1)(n-1)} \\
&\geq \frac{(1 - r_1)(m+1)n + (m+n)(r_1 n - 1)}{(m+1)(n-1)n} \\
&= \frac{(m + r_1 n)(n-1)}{(m+1)(n-1)n}
\end{aligned}
$$

Now $q_1$ is just given by Lemma 4:

$$
\begin{aligned}
q_1 &= \mathbb{E}(A_v)/(m+1) \\
&= \frac{m + r_1 n}{n(m+1)}
\end{aligned}
\qquad \square
$$

# References


Norman W. H. Blaikie. A critique of the use of triangulation in social research. *Quality and Quantity*, 25(2):115–136, 1991. ISSN 0033-5177. doi: 10.1007/BF00145701. URL `http://dx.doi.org/10.1007/BF00145701`.

Alan Bryman. The debate about quantitative and qualitative research: A question of method or epistemology? *The British Journal of Sociology*, 35 (1):75–92, 1984. ISSN 00071315. URL `http://www.jstor.org/stable/590553`.

Lawrence Cunningham, Clifford Young, and Moonkyu Lee. Methodological triangulation in measuring public transportation service quality. *Transportation Journal*, 40(1):35–47, 2000. ISSN 00411612. URL `http://www.jstor.org/stable/20713444`.

W. E. B. Du Bois. *The Philadelphia Negro: A Social Study*. University of Pennsylvania Press, Philadelphia, 1996 [1899].

Tracy Farmer, Kerry Robinson, Susan J. Elliott, and John Eyles. Developing and implementing a triangulation protocol for qualitative health research. *Qualitative Health Research*, 16(3):377–394, 2006. doi: 10.1177/1049732305285708. URL `http://qhr.sagepub.com/content/16/3/377.abstract`.

Stephen Farrall, Jon Bannister, Jason Ditton, and Elizabeth Gilchrist. Questioning the measurement of the 'fear of crime': Findings from a major methodological study. *British Journal of Criminology*, 37(4):658–679, 1997. URL `http://bjc.oxfordjournals.org/content/37/4/658.abstract`.

Menachem Fisch. Whewell's consilience of inductions—an evaluation. *Philosophy of Science*, 52(2):239–255, 1985. ISSN 00318248. URL `http://www.jstor.org/stable/187509`.

Marcel Fredericks and Steven Miller. Some notes on confirming hypotheses in qualitative research: An application. *Social Epistemology*, 2(4):345–352, 1988. doi: 10.1080/02691728808578503. URL `http://dx.doi.org/10.1080/02691728808578503`.

Bernard Grofman, Guillermo Owen, and Scott L. Feld. Thirteen theorems in search of the truth. *Theory and Decision*, 15(3):261–278, 1983. ISSN 0040-5833. doi: 10.1007/BF00125672. URL `http://dx.doi.org/10.1007/BF00125672`.

Carl G. Hempel. *Philosophy of Natural Science*. Princeton University Press, Princeton, 1966.

Eric P. Jack and Amitabh S. Raturi. Lessons learned from methodological triangulation in management research. *Management Research News*, 29

(6):345–357, 2006. doi: 10.1108/01409170610683833. URL http://www.emeraldinsight.com/doi/abs/10.1108/01409170610683833.

Todd D. Jick. Mixing qualitative and quantitative methods: Triangulation in action. *Administrative Science Quarterly*, 24(4):602–611, 1979. ISSN 00018392. URL http://www.jstor.org/stable/2392366.

Udo Kelle. Sociological explanations between micro and macro and the integration of qualitative and quantitative methods. *Historical Social Research / Historische Sozialforschung*, 30(1 (111)):95–117, 2005. ISSN 01726404. URL http://www.jstor.org/stable/20762014.

Larry Laudan. William Whewell on the consilience of inductions. *The Monist*, 55(3):368–391, 1971. ISSN 00269662. URL http://www.jstor.org/stable/27902225.

Kwok Leung and Fons J. R. van de Vijver. Strategies for strengthening causal inferences in cross cultural research: The consilience approach. *International Journal of Cross Cultural Management*, 8(2):145–169, 2008. doi: 10.1177/1470595808091788. URL http://ccm.sagepub.com/content/8/2/145.abstract.

Christin List and Robert E. Goodin. Epistemic democracy: Generalizing the Condorcet Jury Theorem. *Journal of Political Philosophy*, 9(3):277–306, 2001. ISSN 1467-9760. doi: 10.1111/1467-9760.00128. URL http://dx.doi.org/10.1111/1467-9760.00128.

John Mangan, Chandra Lalwani, and Bernard Gardner. Combining quantitative and qualitative methodologies in logistics research. *International Journal of Physical Distribution & Logistics Management*, 34(7):565–578, 2004. doi: 10.1108/09600030410552258. URL http://dx.doi.org/10.1108/09600030410552258.

Conor Mayo-Wilson, Kevin J. S. Zollman, and David Danks. The independence thesis: When individual and social epistemology diverge. *Phi-*

*losophy of Science*, 78(4):653–677, 2011. ISSN 00318248. URL http://www.jstor.org/stable/10.1086/661777.

Phil McEvoy and David Richards. A critical realist rationale for using a combination of quantitative and qualitative methods. *Journal of Research in Nursing*, 11(1):66–78, 2006. doi: 10.1177/1744987106060192. URL http://jrn.sagepub.com/content/11/1/66.abstract.

Mark W. Risjord, Margaret F. Moloney, and Sandra B. Dunbar. Methodological triangulation in nursing research. *Philosophy of the Social Sciences*, 31(1):40–59, 2001. doi: 10.1177/004839310103100103. URL http://pos.sagepub.com/content/31/1/40.abstract.

Mark W. Risjord, Sandra B. Dunbar, and Margaret F. Moloney. A new foundation for methodological triangulation. *Journal of Nursing Scholarship*, 34(3):269–275, 2002. ISSN 1547-5069. doi: 10.1111/j.1547-5069.2002.00269.x. URL http://dx.doi.org/10.1111/j.1547-5069.2002.00269.x.

Julius Sim and Keith Sharp. A critical appraisal of the role of triangulation in nursing research. *International Journal of Nursing Studies*, 35(1–2):23–31, 1998. ISSN 0020-7489. doi: http://dx.doi.org/10.1016/S0020-7489(98)00014-5. URL http://www.sciencedirect.com/science/article/pii/S0020748998000145.

Laura J. Snyder. Consilience, confirmation and realism. In Peter Achinstein, editor, *Scientific Evidence: Philosophical Theories and Applications*, chapter 7, pages 129–149. The Johns Hopkins University Press, Baltimore, 2005.

Richard Tewksbury. Qualitative versus quantitative methods: Understanding why qualitative methods are superior for criminology and criminal justice. *Journal of Theoretical and Philosophical Criminology*, 1(1):38–58, 2009. ISSN 21668094. URL http://search.ebscohost.com/login.aspx?direct=true&db=i3h&AN=57233244&site=ehost-live.

Veronica A. Thurmond. The point of triangulation. *Journal of Nursing Scholarship*, 33(3):253–258, 2001. ISSN 1547-5069. doi: 10.1111/j.1547-5069.2001.00253.x. URL `http://dx.doi.org/10.1111/j.1547-5069.2001.00253.x`.

Robert A. Wortham. Du Bois and the sociology of religion: Rediscovering a founding figure. *Sociological Inquiry*, 75(4):433–452, 2005. ISSN 1475-682X. doi: 10.1111/j.1475-682X.2005.00131.x. URL `http://dx.doi.org/10.1111/j.1475-682X.2005.00131.x`.