

An Ontology-Based Semantic Design for Good Evaluations of Research Practices

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Abstract

The main objective of this paper is to develop a knowledge base for the development of “good” evaluations of research practices. A good evaluation of research practices, intended as social practices à la MacIntyre, should take into account the stable motivations and the traits of the characters (i.e. the *virtues*) of researchers. The development of a questionnaire for the assessment of researchers’ virtues is a challenging task. The use of ontologies and taxonomic knowledge, and the reasoning algorithms that can make inferences on the basis of such knowledge represents a way for testing the consistency of the information reported in the questionnaire and to analyze in a correct and coherent way the data gathered through it.

Keywords: ontology, knowledge-based representation, questionnaire ontology, research evaluation, research practices, virtue ethics.

1. Introduction

We live in an evaluation society (Dahler-Larsen, 2011): evaluations, quantifications and assessments are everywhere and analyse, scrutinize and monitor all kind of aspects of scholarly activities. In addition, in recent decades, the rapid changes taking place in the production, communication and evaluation of research have been signs of an ongoing transformation. Largely, we are facing a transition from a traditional evaluation model, based on indicators (e.g. number of publications and citations) to a modern evaluation, characterized by a multiplicity of distinct, complementary and new dimensions including the so called *altmetrics*. This situation is led by the development and increasing availability of data and statistical and computerized techniques for their treatment, including among others the recent advancements in artificial intelligence and machine learning.

In this context, it becomes increasingly important to “evaluate evaluations”, beyond the convenience calculations of the past (Larson and Berliner, 1983), looking for “good” evaluations. Although there is a proliferation of increasingly sophisticated quantitative methods to evaluate research, there is still a lack of clarity on how to understand and operationalize the notion of “good” evaluation of research practices. Researchers’ motivations and their specific traits of character (i.e. researchers’ *virtues*) have recently been recognized as important factors that must be considered to make a “good” evaluation (Daraio and Vaccari, 2020). Good evaluation takes into account the constitutive elements of *research practices*, intended as *social practices*, according to the MacIntyre view (MacIntyre, 1985; Murdoch, 1998). Following this line, good evaluation must consider researcher’s virtues in the realization of the “internal goods” of the social practice they are involved in.

The main result of this recent study (Daraio and Vaccari, 2020) is the preliminary version of a questionnaire to assess the researcher’s virtues, to be able to complement current research evaluations with additional elements referring to scholar’s motivations and personal threats of character currently excluded by bibliometric indicators in use.

The main objective of this paper is to exploit the properties of ontology-based modelling to represent the domain of researchers' virtues in order to prepare a questionnaire to be administered to researchers. This approach will allow us 1) to check the consistency and the coherence of the questionnaire content and structure before its application (or use) and 2) to correctly and coherently interpret the data gathered through the questionnaire.

The paper unfolds as follows. The next section illustrates the main problems that have to be addressed for the assessment of researchers' virtues. The following section introduces the virtues of researchers as starting point for the semantic modelling of the domain and further elaborates on the questionnaire proposed in Daraio and Vaccari (2020). Section 4 outlines the ontology-based modelling. Section 5 summarizes existing literature on the topics and the last section concludes the paper.

2. Towards the assessment of researchers' virtues: challenges and first steps

The assessment of researchers' virtues is challenged by several pitfalls and problems. The first issue is related to the question of the measurement of virtues. Virtue, it has been argued, seems to consist of a special sensitivity that escapes empirical measurement (Murdoch, 1998). Recently, however, some scholars have tried to undermine this pessimist assumption by giving hope to those of us who seek to develop a model of evaluation of research including also a component based on the virtues. Snow (2014) has recently launched a promising line of research based on the elements of psychology that characterize the virtues. In its perspective *virtue* is composed of the following three elements:

- 1) *intelligence*, which highlights the fact that virtue proceeds from a set of cognitive and emotional mental states that enable us to be sensitive to some morally relevant features of the situations in which, really or imaginatively, we find ourselves (Snow, 2014, pp. 4-5). See also Snow (2010 and 2012);
- 2) *dispositionality*, refers to the fact that this state is a trait of the personality of the agent and is not an occasional element of his psychology;
- 3) *behaviour*, i.e. virtue typically manifests itself in the actions and other behavioural responses of the virtuous person (Snow, 2010, pp. 4-5).

Snow argues that each of these characteristics of virtue can be measured and she outlines a model that consists of three measurement criteria. First, the agent's performance must be taken into account, i.e. the presence of the virtue in question must be verified from the agent's ability to repeatedly perform a given behavioural pattern in the different situations that constitute, so to speak, the field of action of a specific virtue. Secondly, Snow believes it is crucial to take into account the reports that agents make of their emotional and cognitive life during the performance of actions that they consider virtuous. To facilitate this task, Snow believes it is desirable that, on the model of some US colleges, research institutions make available to their participants' special apps that can be downloaded on any electronic device, allowing them to collect the results of the self-observations of agents. Gathering the products of introspection, in addition to offering a useful material to those who are called to assess the presence of virtues in others, also allow agents to take into account the health of their virtues and measure any flexing or, on the contrary, increases in their readiness and effectiveness in responding to the pressures the world exerts on them. Finally, Snow argues that it is important to connect these data with those that impartial observers, in the figure of external evaluators, can collect in the course of annual surveys covering both the outputs of the research and the way in which the researcher dwells in different spheres of social interaction with other participants in the practice.

A further problem to be addressed is which questions to introduce in the questionnaires. These must be sufficiently diversified to allow the evaluators to answer not only the dry question about whether or not there is a virtue, but also to determine the *quantum* of it. Snow suggested four levels to be introduced in the questionnaires.

- I. The first verifies the presence in the agent of receptivity to the *stimulus* that typically activates virtue.
- II. The second examines its ability to recognize the virtue appropriate to the given circumstance.
- III. The third verifies the most complex ability to generate a virtuous response.
- IV. The fourth, finally, measures the ability of the agent to generate the virtuous response in a cross-cutting way to a plurality of situations.

Following the four levels questions introduced by Snow, it is possible to measure on a scale from 0 (minimum) to 4 (maximum) the researcher's mastery of virtue. This is done over a spectrum ranging from (1) the ability to understand the importance of the problem to which virtue constitutes an answer, to (2) the ability to recognize the virtue in question, to (3) the ability to express virtue occasionally, to (4) the ability to manifest it in all situations that constitute the scope of that virtue.

On top of these problems, the traditional problems related to the development of questionnaire and the collection of the necessary information through questionnaire and interview arise (Hochschild, 2009; Rabionet, 2011; Kvale, 2008 and Wolcott, 2008). In this paper we suggest to exploit the advantages of an ontology-based modelling that we will illustrate after the next section, for overcoming the aforementioned problems.

3. Semantic modelling of the virtues of researchers

The starting point for the semantic modelling of the domain in exam are the virtues of researchers.

Let's start with a general characterization of the nature of virtue. Virtues are dispositions to believe, to feel emotions and act in certain ways that are activated when we perceive relevant characteristics in the world. A courageous person, for example, will face danger firmly when she believes that someone or something to which she attaches a value is at risk of being harmed. Similarly, a charitable person when she believes that someone is suffering will tend to sympathize with that suffering and, consequently, take care of it. Furthermore, an accurate person is one who does not accept any belief-shaped thing that enters his or her mind, but takes special care in forming his or her beliefs. Actions of these type will not be singular but will be stable and predictable: whenever she perceives certain relevant characteristics of a situation, the virtuous agent will tend to give the appropriate response to those characteristics. The possession of virtue moreover seems to be something that admits degrees of competence along a spectrum that goes from knowledge about what to do to a more complex one about why to do a certain thing. This element depends on two factors that concern our practice of attributing virtuous traits:

- 1) we sometimes attribute a virtue even when those who perform the corresponding action are not able to give an articulated justification of what they have done and/or their actions are not cross situationally consistent.
- 2) we believe that those who give an articulated justification of their virtuous actions, and tend to manifest the virtuous trait in a coherent plurality of situations, have a greater knowledge of virtue than those who do not. Unlike the former, these agents tend to know how to distinguish circumstances that require a virtuous response from similar ones that do not.

An entirely brave person, for example, will tend to discriminate between the real danger from a mere apparent threat and to avoid facing danger just for the sheer pleasure of the adrenaline that follows. It will also be able to recognize situations that require a courageous response and to be motivated accordingly in a variety of situations: not only those involving physical confrontation, but also those involving, for example, the defense of an unpopular idea or pursue a complex line of research never explored before. In a similar way, an entirely accurate person takes into account that research is both time- and resource-consuming and is able to put different investment policies in place depending on circumstances. These agents seem to possess greater knowledge of the virtue of those who simply act virtuously in a limited number of cases and lack the ability to formulate a justification for what they do. They are able to articulate the reasons in favour of virtuous behaviour in a plurality of contexts and use them to justify their conduct to themselves and others. For those who possess this knowledge virtue will not be a mere disposition to act, but a disposition to act infused by a reflective ability that involves the mastery of concepts. As with other character traits, finally, virtues are *profound qualities* that reveal what kind of person is the one who possesses them. The attribution of character traits is in fact a common practice that we use as much to get a general idea of someone we do not know well as, if we know him better, to predict what he will say or do or to explain why she has made certain choices in the past. Moving from the spectator's point of view to that of the agent, there are facts that are typically explained (retrospectively) by referring to motives that depend on general principles of our conduct that survive that individual case. Although not all of these principles are something we necessarily approve of, some of them are aspects of our character that are valued by ourselves and others and that we strive to maintain, creating opportunities to test them and reflect on how we express them in our behaviour. In these cases, virtue becomes a crucial element of our narrative and plays a normative role in our future choices.

In our research we are going to use two different types of virtues: the *intellectual* or *epistemic virtues* and the *virtues of character*. The former involve dispositions to exercise a set of capacities that relate to how we acquire our beliefs and communicate them to others. The latter, on the other hand, concern functional ways in which we enter into relationships with ourselves and interact with others by promoting our own and their good. The former are developed primarily through teaching by specialized staff (professors; research directors; etc.). The latter, on the other hand, require having entered into a non-emulative educational relationship with figures who have the role of educators in the community (parents, teachers, etc.).

Below we provide an open-ended list of the virtues that enable the constitution of a good research practice and constitute something that should be taken into account by those making comparative judgments about the relative value of different research practices in addition to existing and currently used individual bibliometric indicators. For an extensive discussion on these individual bibliometric indicators, see Schubert and Schubert (2019) and Wildgaard (2019). Schubert and Schubert (2019) offer an overview on h-index related indicators while Wildgaard (2019) presents a summary of existing author-level indicators of research production.

The virtues that enable the constitution of a good research practice include:

a) *Intellectual virtues:*

Accuracy: it is the disposition that consists in the care with which the individual researchers collect data that will constitute the pool of information shared in the research practice. Since collecting and evaluating information is time and resource consuming, the accurate researcher

is one who implements several “policies of investigation” that are appropriate to the research circumstances (Williams, 2002).

Sincerity, Honesty: it is the disposition to tell the truth to others and, when this does not happen, it is the capacity to indicate good reasons why this did not happen where good refers to the fact that these reasons have a constitutive reference to the interests of other people (McIntyre 1985, Williams 2002).

Creativity: is the ability, which finds expression both in our social interactions with others and in the products of our research, to produce something that not only has value but is characterized by the elements of novelty and the capacity to arouse surprise in others (Swanton 2003, pp. 162, 165).

b) Virtues of character useful to oneself:

Humility: it is the ability to accept the authority of the standards related to the rules that define the practice. I have to recognize that other participants know rules and know how to apply them better than I do. I have to be willing to learn from these people and accept their criticism (MacIntyre 1985, p. 193).

Pride: it is evaluative attitudes towards ourselves (Ardal, 1966; Cohon, 2008; Taylor, 2015). Unlike other emotions, which simply motivate us to pursue or avoid objects, this traits of character fix our attention on persons, casting a positive or negative light on them. If I am proud of my child’s success at school, my pride does not fix my attention on the ‘merits of my child,’ and still less on ‘me in the role of father,’ but on the whole of myself. As Cohon has rightly said, “when I feel pride, I am proud of something in particular [its cause] ... But the attitude of pride is a pleasure or satisfaction not in that particular accomplishment or possession, but in myself in my entirety” (Cohon, 2008, p. 166). We believe that the pride associated with one’s own achievements in research and the consequent approval of one’s peers or superiors is a fundamental spring that drives researchers to perform at best in their area of research (Tangney, 1999).

Patience is the ability to curb one’s own urge to complete a research in order to obtain as soon as possible the gratification of a positive result. To be able to wait and to be guided by a cautious skepticism that prompts us to control accurately the different steps of our investigation.

Prudence: is the capacity to sacrifice the satisfaction of less important pleasures closer in time than the satisfaction of more distant but more important pleasures. Where the degree of importance is defined with respect to the long-term objectives that characterize our lives (Parfit 1984).

Resilience: together with pride, this ability is indispensable to move forward in the research. It allows us to leave behind failures (paper rejected, unfunded projects, etc.) and to focus on future projects (Hormann, 2018).

c) *Virtues of character useful to others*

Courage is the capacity to risk damage or danger to oneself when individuals, values, goals that are crucial to the existence of the practice are at stake. Courage is therefore a way of showing that our attachment to these elements of the practice is genuine (MacIntyre, 1985, p. 192).

Empathy, Benevolence: in line with extensive literature, by this term we mean the human ability to feel the emotions and feelings of other people through a vicarious feeling that is similar to that of the person with whom we sympathize. We do not believe, however, that empathy in itself is a virtuous capacity in research practices. Since empathy is an instrument for reading the other's mind, it can also be used to manipulate other researchers in malicious ways. Empathy must be cultivated in such a way that it is rooted in the benevolent tendencies of human beings (Batson 2017, p. 2). In this way, empathy can allow the creation of a climate of *trust* between those who work within research institutions. Indeed, mutual trust is an indispensable component in these practices given the fundamental fact of the asymmetry of power that characterizes those interactions (Baier, 1991).

Integrity: is the willingness to behave in such a way that our actions are the outcome of our deepest values and commitments and that we tend to refuse making them hostages to imposed obligations or duties that we do not endorse on reflection.

Justice: following Aristotle (Aristotle 2014, Book V), we distinguish justice into two aspects. The first relates to the ability to promote the good of other researchers as members of our institution and research unit, that is, those to whom we are bound by ideal bonds and common respect for the rules that define our research community. The second is in turn divided into two spheres. The first concerns the ability to distribute the goods of research practice appropriately on the merits. The second, on the other hand, is the ability to compensate for or punish poor distributions or misconduct.

Practical wisdom: it is a kind of *super-virtue* essential to make each virtue effective. In line with Aristotle, we believe that this rational capacity enables the virtuous agent to acknowledge and respond properly to the items in the field of the research practice, choosing the appropriate means for their own ends (McDowell, 1979). Moreover, it also allows the different virtues within an individual's character to operate and develop harmoniously with each other.

A first attempt to develop a questionnaire for the evaluation of virtues in research practices has been done by Daraio and Vaccari (2020). Our Table 1 below, elaborating further Table 1 of Daraio and Vaccari (2020, p. 1067-1068), proposes some examples of questions to consider in evaluating the virtues of researchers.

Table 1. Examples of questions to include in the Questionnaire on Researchers' Virtues

a) Intellectual Virtues	Questions
<i>Accuracy</i>	<ul style="list-style-type: none"> - Do you thoroughly collect all the pieces of information that constitutes the body of knowledge on which the practice revolves? - Do you evaluate this disposition as instrumental or intrinsic? - Do you have a tendency to share data, results, methods, ideas, techniques, and tools used in the practice?
<i>Sincerity, Honesty</i>	<ul style="list-style-type: none"> - Do you think there are circumstances in which your colleagues can be manipulated? - Are you inclined to admit publicly when you make mistakes?
<i>Creativity</i>	<ul style="list-style-type: none"> - Are you able to explore and follow your own line of research? - Do you have the tendency to question your own ordinary experience and look with suspicion at what is the result of habit?
b) Virtues of character useful to oneself	Questions
<i>Humility</i>	<ul style="list-style-type: none"> - Are you incline to recognize that other researchers (participants to the practice) know rules and know how to apply them better than you do? - Are you to be willing to learn from these people and accept their criticism?
<i>Pride</i>	<ul style="list-style-type: none"> - Are you able to gain an impartial knowledge of one's own qualities? - Do you have the ability to feel fulfilment for academic success through demonstrating competence according to social standards and to draw strength from one's achievements? - Do you think you have a stable awareness of your own value that is not shaken by the successes of others? Do you have the capacity to enjoy and congratulate other people' accomplishments?
<i>Patience</i>	<ul style="list-style-type: none"> - Are you able to curb the rush to hastily complete a search to achieve the gratification that comes with a <i>prima facie</i> positive result? - Are you willing to be guided by a cautious scepticism that prompts you to control accurately the different steps of our investigation?
<i>Prudence</i>	<ul style="list-style-type: none"> - What do you think about people who tends to restraint of actions, inclinations, and impulses that are likely to upset others? - Do you tend to respect the fundamentals of the research practice within which one works?
<i>Resilience</i>	<ul style="list-style-type: none"> - Would you describe yourself as a person who leaves behind failures (paper rejected, unfunded projects, etc.) and to focus on future projects?

c) <i>Virtues of character useful to others</i>	Questions
<i>Courage</i>	<ul style="list-style-type: none"> - Are you willing to risk damage or danger to oneself when individuals, values, goals that are crucial to the practice are at stake? - Do you have a propensity to apply for highly competitive grants?
<i>Empathy, Benevolence</i>	<ul style="list-style-type: none"> - How do you feel about people who are sensitive to the suffering of their colleagues caused by failures or exclusions? - How do you feel about people who seeks feedback to improve interactions with others? - Do you think that preservation and promotion of the welfare of people with whom one is in frequent personal contact is important? - How would you describe collegial engagement?
<i>Integrity</i>	<ul style="list-style-type: none"> - Do you think that to hold beliefs that are consistent with actions has always a positive value?
<i>Justice</i>	<ul style="list-style-type: none"> - Does the practice of distributing funds, grants and awards according to merit always have a positive value? - Do you tend to think that the situations in which researchers work have commonalities that would allow for comparisons of their accomplishments?
<i>Practical wisdom</i>	<ul style="list-style-type: none"> - Would you describe yourself as someone who tends to choose the most effective means to achieve their ends? if not, why? - Have you ever been in a situation of conflict between things that have identical value to you? If so, what considerations do you turn to in an attempt to resolve the conflict?

Note: The content of this table is an elaboration of the content of Table 1 by Daraio and Vaccari (2020, pp. 1067-1068).

4. Designing an ontology for the modelling of researchers' virtues: Implementation aspects

Formally, an ontology in Description Logics is a knowledge base. It is a couple (pair) $O = \langle TBox, ABox \rangle$, where TBox is the Terminological Box that represents the *intensional* level of the knowledge or the conceptual model of the portion of the reality of interest expressed in a formal way; and ABox is the Assertion Box that represents the *extensional* level of the knowledge or the concrete model of the portion of the reality expressed by means of assertions (instances).

The use of ontology-based modelling in our context allows us to implement *cognitive interviewing methodology* to address the challenges outlined in the previous section. Cognitive interviewing is a psychologically oriented method for empirically studying the ways in which individuals mentally process and respond to survey questionnaires. Cognitive interviews can be conducted for the general purpose of enhancing the understanding of how respondents carry out the task of answering survey questions. However, the technique is more commonly conducted in an applied sense, for the purpose of pretesting questions and determining how they should be modified, prior to survey fielding, to make them more understandable or otherwise easier to answer. The notion that survey questions require thought on the part of respondents is not new and has long been a central premise of questionnaire

design. However, cognitive interviewing formalizes this process and it has become an interdisciplinary field (for an overview, see Willis, 2004 and Miller et al., 2014).

An ontology-based semantic modelling approach offers several advantages, including:

- i. a conceptual specification of the domain of interest, in terms of knowledge structures;
- ii. the mapping of such knowledge structures to concrete data (the answers of the questionnaire);
- iii. the reasoning over the abstract representation of the domain prior to the data collection;
- iv. a flexible conceptual system that can be easily updated;
- v. an open conceptual system that can be used as a common language for the research community.

The languages for representing ontologies and taxonomic knowledge, and the reasoning algorithms that can make inferences on the basis of such knowledge have been addressed by a large body of research in Artificial Intelligence and Knowledge Representation. Their formal characterisation is nowadays based on Description Logics (Baader et al., 2003), which provides a syntax for concept and role expressions and formal semantics to interpret them in a set theoretic framework. Concepts (i.e. classes) model sets of individuals and roles model binary relations. The representation of ontological knowledge is thus achieved by defining concepts and the properties (relations) that link them to other concepts in the domain of interest. The concepts are arranged in a hierarchical structure based on the subsumption relation (i.e. set containment). Along with the formal language, systems that allow to model and use ontologies are accompanied by various forms of syntactic representation, including graphical models. Protegé (Gašević et al., 2009) is a standard tool that builds its success, among other things, on the capability to handle multiple syntactic representations that allow the user to model the domain of interest using the most convenient notation, while grounding it to a well understood formal counterpart. Another key feature of Protegé is the decoupling of the representation from the reasoning tool that is adopted to make inferences. Protegé, for all the reasons explained above, will be used for the development of the ontology for the assessment of researchers' virtues.

5 Related works

While there is a rich literature and several approaches for extracting information through ontologies, for a review see Wimalasuriya and Dou (2010), the literature on ontological modelling in support of questionnaires development is scant. Notable exceptions include Sherimon et al. (2013 and 2014) where an ontology-based model for gathering the patient medical history based on dynamic questionnaire ontology is developed. The model is implemented and explained for diabetes domain by using Protegé. Another interesting contribution is Borodin and Zavyalova (2016), in which the authors focused on the problem of semantic representation of questionnaires. They constructed the generic ontological model of questionnaire, which provides a possibility of question structure description including complex questions with a set of answers of different kind and question order, including skipping and branching.

Surveys in fact, may be conducted to gather information through a printed questionnaire, over the telephone, by mail, in person or on the web, etc. and the structure of survey questionnaires and feedback if described in ontological terms provides an opportunity not only to structure the survey data but also to analyse the responses.

We contribute to enrich the limited existing literature, showing the potential of ontology based modelling for challenging and intriguing topics as the “good” evaluation of research practices, that relates the development of a questionnaire for the assessment of the motivations and the stable threats of characters (or virtues) of researchers.

6. Concluding remarks

This paper is realized within a challenging and interdisciplinary research project on “Evaluating Evaluations” with the financial support of Sapienza University of Rome. Based on the conceptual tools used by normative ethics, in particular from the perspective known as ethics of virtues, we have started to develop a questionnaire capable of revealing the presence and quantity of virtues in individual researchers. We believe that the use of ontology-based modelling in this context might enable us to further implement a cognitive interviewing methodology which may help us to address the many challenges of this research field.

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