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Perspectives of key stakeholders on essential virtues for good scientific practice in research areas

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ABSTRACT

In contrast to the principle-based approach to ethics and research integrity (ERI) training, which stresses the importance of following moral rules, the virtue-based approach focuses on developing good character traits. This study has aimed to explore what virtues mean in scientific practice and their suitable place in ERI training, using a qualitative approach. Two face-to-face focus group discussions were conducted with 21 participants. Heterogeneous purposive sampling was used to reach participants from different countries, organization types (academia, research, publishing, private sector), scientific disciplines and stages of their scientific careers. Data generated during the focus group discussions were analyzed using a reflexive thematic analysis approach, and three main themes were developed. The first theme addressed the relativity of virtue meanings because the participants differed in their definitions and understandings of the concept of virtue. The second theme referred to the acquisition of virtues through social interactions because participants saw virtues mostly as social constructs acquired through socialization and education. The third theme addressed the differences in the importance of particular virtues in research. Participants felt that particular virtues were more important than others because some of them are necessary for responsible research, and some are not.

Introduction

Modern scientific research is compromised by difficulties in the replicability of research findings (Ioannidis 2017), serious forms of scientific misconduct and reports of widespread research misbehaviors (Martinson, Anderson, and de Vries 2005; Pupovac and Fanelli 2015). These practices produce misleading results, waste resources (Ioannidis et al. 2014) and decrease public trust in science (Mojon-Azzi and Mojon 2004). Therefore, the scientific community needs to ensure the highest levels of ethics and integrity in research. Interventions to promote ethics and research integrity (ERI) or deter misconduct have been tested in several research settings, but these findings

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indicated that they might not be as effective as intended (Antes et al. 2010; Marusic et al. 2016). However, most of these approaches to improve integrity in research are principle-based in that they portray ethical conduct as consisting of adherence to ethical rules, duties, or responsibilities (Resnik 2012). Furthermore, approaches focusing only on compliance and neglecting the development of a researcher' intrinsic values do not provide adequate guidance for the real-life research and situations not covered by rules and codes (Pennock and O'Rourke 2017; Steele et al. 2016).

In contrast to the principle-based approach, the virtue-based approach focuses on developing good character traits, allowing researchers to go beyond mere compliance by motivating them to strive for excellence in themselves and in their practices (Pennock and O'Rourke 2017). Compliance and development of good character traits are not, however, mutually exclusive. Virtue-based and principle-based approaches to ethics are complementary because they focus on different aspects of ethical conduct. Principle-based approaches stress the importance of following moral rules, while the virtue-based approaches emphasize moral character development (Resnik 2012). Hence, researchers need to develop moral sensitivity and foster habits that will motivate a person to exemplary practice, which inspires them to act in the right way (MacIntyre 1981; Pennock and O'Rourke 2017). For that purpose, they also have to be provided with adequate guidance based primarily on a virtue ethics approach to research integrity.

Previous studies have shown that researchers value this virtue-based approach and even prefer it over traditional methods of research integrity training (Berling et al. 2019; Palmer and Forrester-Jones 2018). Although virtues have been studied and discussed within moral or character education (Berkowitz and Bier 2004; Carr and Steutel 2005b), there is a lack of research on scientific virtues. Some attempts have been made to learn what traits scientists value most in one another. As a part of the Scientific Virtues Project, an ongoing empirical pilot study endorsed by US scientists had identified honesty and curiosity as the most important traits underlying excellent science ("Character traits: Scientific virtue" 2016; Pennock and Miller 2019). Furthermore, almost all of the surveyed scientists believed that scientific virtues could be learned. In order to develop a virtue-based training program, it is necessary to further develop the evidence base regarding scientific virtues in the context of good research practice. Considering there is a gap of knowledge on a virtue-based approach to research integrity, qualitative research could help to uncover new insights on scientific virtues and explore what they actually mean to researchers. This study aimed to use a qualitative approach to explore researchers' understandings of virtues in scientific practice and how virtues can be taught in ERI training.

Methods

Study design and participants

As a part of the Horizon 2020 VIRT^{2}UE project, which aims to develop a sustainable train-the-trainer blended learning program enabling contextualized ERI teaching across Europe, two face-to-face focus groups were conducted with key stakeholders in order to gain an insight into their perspectives on essential virtues for good scientific practice in research. Since we aimed to explore new insights and explanations about social behavior, cultural values or community opinions on this topic, the group context of a focus group setting was an ideal method for our study (Hennink 2007). The methodological orientation used to underpin this study was a reflexive thematic analysis approach developed by Braun and Clarke (Braun and Clarke 2006; Braun et al. 2019). There were 21 participants, 14 in the first and 7 in the second focus group. We used a heterogeneous stratified purposive sampling to reach participants from different domains who were currently active at some stage of the research process and who are representatives of the following stakeholder groups: academics (n = 5), ERI committees (n = 3), policymakers (n = 3), funding and process organizations (n = 2), students (n = 6), private sector (industry and small and medium enterprises) (n = 5). The sum of the roles represented exceeds the number of participants because three participants belonged to two different stakeholder groups. Both genders were represented (57.1% female and 42.9% male), and researchers with different research experience levels were included (the median age of participants was 36 years, range 25–70). The most common research discipline amongst the researchers who participated was biomedicine, followed by social sciences. There were also representatives of humanities, natural sciences and applied sciences. Ten European nationalities were represented, and one participant was from the USA. All participants were approached via e-mail and asked to participate in a focus group discussion regarding scientific virtues. For the first group, we had 17 expressions of interest for the participation, and 14 were able to join the focus group. Three invitees could not participate because of their travel itinerary to the project meeting in Split. For the second focus group, the invitations were sent to 12 participants at the project meeting in Aarhus, and 5 could not attend because they had prior travel plans at the time of the focus group. COREQ checklist for interviews and focus groups was used as a reporting guideline for writing this manuscript (Tong, Sainsbury, and Craig 2007).

Setting and data collection

Focus group discussions were held during other EU project meetings because it was the most efficient way to include international experts from different

research domains in a face-to-face focus group meeting. The first focus group discussion was held at the University of Split School of Medicine in Split, Croatia, in October 2018. It was conducted in two rounds using a self-developed discussion guide (Appendix A). The first round took about 65 minutes, and the second round took about 40 minutes after a short presentation of our project and principles and practices of The European Code of Conduct for Research Integrity (ALLEA 2017). With this design, we aimed to get more naïve responses during the first round and compare the differences. During both rounds, only the participants and researchers were present in the room, and most participants were not familiar with the research team before the beginning of the study. IB was the facilitator of the first round, VT was the facilitator of the second round, and another colleague (DP) was an observer of both rounds. Both facilitators were males, enrolled in a PhD program, employed by the University of Split School of Medicine, with previous experience and training in qualitative methodology (Buljan, Barać, and Marušić ; Tomić, Relja, and Popović 2015). After preliminary analysis, the scripts were adjusted (Appendix B) by VT and IB for the second focus group meeting, which took place at Aarhus University in Aarhus, Denmark, in January 2019. Since the separation of the first focus group discussion into two rounds did not show any differences, the second focus group discussion was conducted in only one round without any presentations, and it took about 70 minutes. During the discussion, nobody but the facilitator (VT), observers (IB and another colleague, RŠ) and participants were present in the room. None of the researchers had previous relationships established with participants. A digital audio recorder was used to record the discussions, all of which were conducted in English. Recordings of the face-to-face discussions were transcribed verbatim and anonymized by VT and checked for accuracy by LB. Field notes were made during the first focus group discussion by VT and DP, and by RŠ during the second focus group. The transcripts were not returned to participants for comment or correction, and they did not provide feedback on the findings. In both focus groups, a specially constructed questionnaire was used to collect basic socio-demographic data from the participants (Appendix C).

Data analysis

Qualitative data were analyzed using Braun and Clarke (2006) six-phase guide to performing thematic analysis, as the theoretical freedom of this approach allows great flexibility, which can provide detailed and complex understandings. Following the familiarization with the data through transcription, reading and re-reading, initial codes were generated and gathered into potential themes. After reviewing themes across an entire data set, a thematic map was developed, and clear definitions and names for each

theme were identified and further refined through ongoing analysis. Data were coded by VT with an inductive approach; themes were also developed by VT at a semantic level and discussed with all authors. In this approach, themes were not conceptualized as domain summaries based around data collection tools, but as a reflection of shared meaning-based patterns organized around a core concept or idea. Themes capture the implicit essence of meanings "under the surface" of the data that occurs in multiple and varied contexts across large partitions of a dataset (Braun et al. 2019). Concepts of data or code saturation were not used in this study because they were not consistent with reflexive thematic analysis values and assumptions (Braun and Clarke 2019). All data analysis was performed using a qualitative data analysis computer software NVivo 12 Plus for Windows (QSR International Pty Ltd., London, UK).

Ethics considerations

Face-to-face focus groups with stakeholders were performed after obtaining approval from the Ethics Committee of the University of Split School of Medicine (Reg. No.: 2181-198-03-04-18-0044). All participants received and signed the informed consent form before a focus group meeting. Anonymized transcripts of the focus groups will be kept for up to 10 years after the end of the VIRT^{2}UE project, and will be available at the VIRT^{2}UE project web-site according to the FAIR principles (Wilkinson et al. 2016).

Results

The following three main themes were developed from the data: 1) relativity of virtue meanings and understandings, 2) acquisition of virtues through social interactions, and 3) differing importance of particular virtues in research (Figure 1).

Relativity of meanings and understandings of virtues

Virtues in our study were recognized as something which does not have clear boundaries, as the participants had different understandings of virtues as a concept. They also ascribed different meanings to particular virtues. Moreover, several participants emphasized that even the word "virtue" represents an abstract idea that may be difficult to define.

  P8: Honesty, respect, reliability, so to a different people, they mean different things as we all establish.
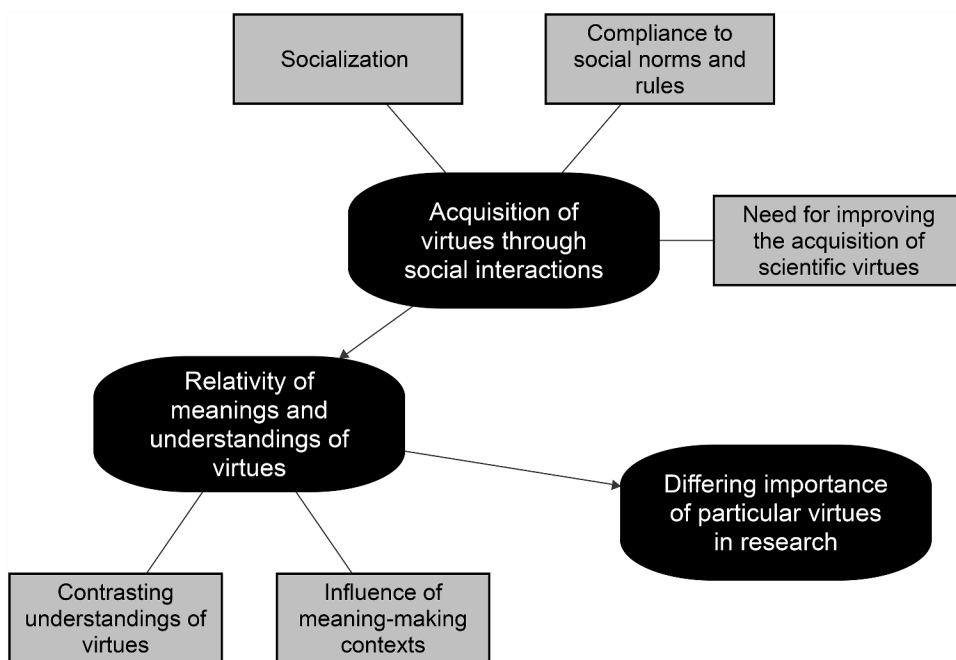
Figure 1.

P11: […] virtue is very abstract word that I can't really understand. Even when I translate it to my language, it's difficult to know what it means.

Thus, it seemed that virtue meanings and understandings are quite relative and could depend strictly on personal judgments. For this reason, our first developed theme deals with the relativity of virtues, which is further presented in subthemes "Contrasting understandings of virtues" and "Influence of meaning-making contexts".

Contrasting understandings of virtues

The participants tried to define and explain the meanings of virtues in various ways. Some of them identified virtue solely as an internal characteristic of a person or traits defined by upbringing, which can be meaningfully shaped over time, while others saw them as moral norms or acts of self-reflection.

P7: […] something you internalize during your childhood and so on. So virtue has to be a high moral standard that is internalized. So if you don't have it in yourself, it's not the virtue, in my definition.

P8: It's usually to describe something that is your characteristic, not something that you developed but something that you realize about yourself.

To overcome difficulties with exact explanations of virtues, some participants tried to define them using some specific virtue as an overall

characteristic of the generic term itself. Also, they frequently used their antonyms, which are, in this case, vices. This use of negative definitions also suggests confusion in understanding of the term since it is a lot easier to indicate the absence of some characteristic or its contradiction than the presence of distinguishing features.

P19: […] um, well, what I mean by virtue? I think it carries a connotation of trustworthiness …

P5: It's very difficult to identify, recognize and describe positive behavior. […] It's a lot easier recognizing, identifying and then treating bad behavior.

Regardless of individual differences in understanding the term itself, most participants saw virtues as personal characteristics, traits of admirable quality, or particular moral excellence. They generally identified virtues as something good or positive.

P2: […] it's a personal characteristic, it's something related to, it's a highlight. Something you are proud of, something you want share with others or highlight in others, in hiring it can be something important, generally something positive.

P1: Virtue … I don't know … Something good, it's a trait or quality …

However, even the identification of virtues as positive brings a certain amount of relativity since some of our participants suggested that something generally considered positive can also be perceived as negative. Specifically, too much of virtue can lead to something opposite; for example, too much creativity can result in data fabrication.

P8: […] you want creative person as Ph.D. student but not as creative to make up the whole paper.

Moreover, several participants argued that even something opposite of virtues, such as ruthlessness, can be presented to appear as a positive behavior. Also, our judgment of positive or negative behavior depends on the inner motivation of a person who acted in a certain way. For example, dishonesty can be just an honest mistake if it is not committed on purpose, but a person can also be considered virtuous if they are dishonest in order to be polite and considerate to other people.

P12: But ruthlessness could then be translated to clarity of purpose, focus …

P13: Like it's that example, what you said about submitting your research more than once …

P10: […] I wouldn't call that being dishonest if you genuinely didn't know …

P13: [crosstalk] I would call it being dishonest …

P10: Oh, no, for me it is a convention and, um, you broke that convention if you … I mean, if you did really know you shouldn't do it and said you didn't, that would be dishonest but to break a rule you genuinely didn't know, to me, it's not dishonesty.

Furthermore, an attempt to show others that you are a good person to gain praise or acknowledgment for your own righteousness can be seen as something opposite of being virtuous. This kind of behavior can be described with the phrase virtue signaling:

P4: […] in US you hear a lot about virtue signaling […] Um, you know, when man say look at what virtuous person I am, but there is virtue I'm signaling you without saying I'm virtuous [in] all the things I do. So it's taken on a, I would say, sort of, false. It is if you're presenting yourself in a much more flattering light than you should. So it's taking a little negative connotation.

Influence of meaning-making contexts

This discussion on the definition of virtues revealed that participants understood virtues under the influence of different meaning-making contexts, primarily religious context, sociocultural context and psychological context. For some participants, religion was the first association for virtues because many individuals may derive their moral principles from the religious guidelines and leaders. Others said that virtues have a non-religious meaning to them. They emphasized that religion is not a necessary condition for being virtuous, and they rather saw virtues as a part of general morality.

P13: I agree on that, first thought would be religious …

P10: Yeah, but I think lots of us got our moral codes from religion, which is why it has that sort of religious connotations, but it doesn't have to, but it's often mystique …

P5: So the virtues you have growing up, whether it be religious or non-religious. I mean, virtues mean also non-religious for me. It's not the first thing that comes in mind – religion. I would say knighthood will be the first thing comes to mind when I said virtue.

Participants generally agreed that virtues are a social construct, which means that our understandings of them are influenced by social groups or circles under which we share common traditions, beliefs, collective activities and interests. Hence, the relativity of virtue meanings could also be based on

shared culture because different societies can have a different value system. These value systems can cause diverse ways of looking at things, leading to problems in interpreting another person's actions.

P16: I don't think that we're necessarily born with the virtues intact. Actually, I think we're born as blank slates and in many instances and we learn a good deal from our parents or siblings, our wider social circles, our schools and so on.

P10: I think it could be different in different societies as well because, for example, loyalty to your family as opposed to loyalty to your country or whether you feel you should break the law in order to protect a member of your family. So that's a relative thing, it's not an absolute thing.

The relationship of influence between society and virtuous scientists goes both ways. Scientists' violation of professional codes of scientific research and ethical behavior can be even viewed as jeopardizing society's functioning since its consequences could be devastating.

P5: If you're plagiarizing, I would say that's somehow a sin against a fellow researcher … But if you're fabricating and falsifying research […] that applies that you are actually undermining the society itself. Science definitely, the society in large probably.

P20: But I think, you know, there is a lot of social science research that underestimate the impact that they could have in society at large, in negative terms, rather than positive terms. Perhaps justifying some weird ideology or …

The concept of "virtue" may have more than one meaning and may depend on personal viewpoints, beliefs or feelings. Participants frequently described virtues as personal traits or personal characteristics that can evolve from psychological factors. These characteristics are essential in selecting other researchers to cooperate at the workplace or during education. To achieve that, participants considered equally important to consider both their personal characteristics and their achievements.

P1: […] I value if a person has a good record and can supervise me for the while. And then slowly can move on to working in another working environment if the personal characteristic does not fit me.

Facilitator: So, in order to collaborate with another researcher, um, do you look mostly at their academic achievements or you also try to judge their personality, their character traits?

P17: Yeah, both. I mean [...] lot of us notice that working with difficult people really is not very productive and just a hassle and annoying, so yeah, both aspects I would say, but problem is of course you often only learn that by going through experience ...

Acquisition of virtues through social interactions

This theme deals with factors that influence the acquisition of virtues. It includes three subthemes: 1) socialization, 2) compliance to social norms and rules, and 3) need for improving the acquisition of scientific virtues.

Socialization

Participants recognized socialization as highly important and continuing process in which individuals acquire virtues. This means that virtues are not an inborn quality and that a person can become a good researcher only through interaction with others. Some participants emphasized that the emulation of expected behaviors can be a useful observational learning mechanism in this process.

P15: It's a little bit about it like children, they do what they see and not what they hear, so ... And, and that, and in that we, I think we're socialized into being good researchers.

P5: And the researcher can try to emulate the behaviors, the expected behaviors of their surroundings, whether micro or macro surroundings to continue behaving integrally or virtuously.

Since education is one of the socialization agents, it is not surprising that its importance was a frequently discussed topic amongst participants from both focus group meetings. Participants pointed out that learning, training, and mentoring are crucial for good research practice.

P1: Yes, virtue can be developed, it might take training, it might take reflection, but it certainly can be developed at some consideration.

P8: But good research practice also can be and must be learned.

Several participants described the importance of mentoring for the acquisition of virtues and the initiatives to strengthen coaching skills. Mentors have a significant impact on behavior, so their students will model and echo the behaviors they see in them, especially if they admire them.

P6: [...] I think if you have a good P.I. who's a good mentor that there's no reason why you can't be taught good research practices, yeah, and you might kind of become a person could get sloppy and thinks like that

but I think if you start early enough, then it's given good chance to be kind of engaged in a good research practices.

P16: But also I think you will eventually absorb those virtues and you know there's been a lot of very interesting work done in the States by Melissa Anderson, people looking at and the impacts of let's say ethics teaching and supervision and what they found was that actually delivering a course has very little impact on how people view the world and their behaviors. But actually, their mentors have a huge impact on the behaviors so they will and they will model and echo the behaviors they see in people that they admire.

Some participants emphasized the lack of training in research integrity for poorly done research because without training, researchers cannot have the competence, and there is no reason to put trust in their conclusions. In contrast to that, other participants pointed out that teaching in ethics today has little or no effect since some studies showed a significant decline in acquired knowledge after some time. However, the reason for this decline of knowledge could be in other incentives from the environment that outweighed individual courses in ethics.

P19: [...] without training, without competence, um, they don't have an integrity in the sense of you don't really trust the conclusions that they reach.

P19: Teaching in ethics has been shown to have almost no impact.

Compliance to social norms and rules

Participants identified "following the rules" as one of the main aspects of the acquisition of virtues. They pointed out that researchers who follow the rules are more likely to be virtuous and vice versa. Some participants also emphasized that following the rules is a crucial part of research integrity because it means adhering to professional standards. However, following the rules does not make one a virtuous scientist.

P11: I think that rules, people who are virtuous would be more virtuous because they would follow them and people who don't follow the rules would not.

P5: Well, ethics is part of your moral reasoning, research integrity would be the one following the rules. [...] Not saying that "Oh, all you have to do is following these rules and that determines whether you virtuous or not. Even in the research setting.

Some participants suggested that there was a distinction between a virtuous researcher and virtuous research. They pointed out that it may take a long time to determine whether a piece of research is virtuous or not,

but a virtuous researcher can be detected relatively quickly because they followed the rules.

> P12: So is then there a distinction between the virtuous researcher and virtuous research and the second one, the virtue of the research, may not actually be known at the time. It may take 5, 10, 15 years to find out that what's good, moral good, what benefits to humanity that has actually had. Whereas the virtuous researcher can be detected recently quickly because that he's following rules.

However, learning rules can also have negative connotations because some people want to know the rules just to get around them.

> P4: They did learn the rules because they want to figure how to get around them …

Need for improving the acquisition of scientific virtues

It appears that participants generally think that today's dominant approach to ERI training should be improved, which can then also lead to better acquisition of virtues in scientific practice. A possible approach could be the combination of the principle-based approach and virtue-based approach.

> Facilitator: Would you prefer scientific, um, virtue approach or this, to research ethics and research integrity training or this traditional approach based on rules and codes?
>
> P5: I wouldn't stick with either; I would do a mix. There is definitely room for improvement on today's approach. […] So I would do both, I would both teach, I would tell the researchers the emulate, what the behaviors are that they need to emulate …

Participants identified learning by example as a far more powerful experience than being lectured or forced to learn a specific set of instructions. That can be achieved with trainers who are exemplary and virtuous researchers themselves or by showing the consequences of different behaviors to trainees.

> P19: But if you're going to provide somebody with training, you know, it's good to have a concrete example. And I guess it might be parallel to would you learn as much from reading a recipe book on how to create a risotto or if somebody took you through the steps of actually getting the rice out and doing this that and the other.
>
> Facilitator: And what can trainers do to encourage researchers to integrate virtues in their everyday practice?

P7: Show by their own example … That they have that, those
  virtues.

Some participants identified practices of giving the same examples for
different scientific fields and disciplines as being ineffective. In order to get
students more involved, it is necessary to provide them with examples from
their own disciplines.

P18: What would be different is how you teach them. That should go,
  I think, where discipline. Like if you want to really make people get
  more involved. If you're a humanities and then you just get examples
  from medicine …

To improve the process of acquiring scientific virtues, the participants
suggested using several teaching methods and tools. Ethical dilemma and
case study were recognized as an essential and highly influential teaching
tools because they encourage students to communicate and collaborate
to find solutions, solve a problem or make a decision in a specific
situation.

P19: I periodically would try and teach a bit of ethics with case studies and
  there were one or two rather interesting and challenging […] but I, I've
  found the students really quite taken with ethical dilemmas.

Participants also mentioned some useful examples that can be used in
training, particularly dilemma card games and clips from popular films,
because it could be a potent and exciting teaching tool due to its attractive-
ness to students. Some participants pointed out that continuous education is
also needed because knowledge must be updated due to the ongoing devel-
opment of ethical principles and new regulations.

P16: And what they were doing was they were actually getting, taking clips
  from well-known movies that pretty you know, All the President's Men
  and I think Aliens, one of them, whatever, that presented a moral
  dilemma.
P10: … it isn't just a case of once you`ve done the training, that's it, you
  immunized for life and you're going to be a good researcher, sadly no.

Differing importance of particular virtues in research

Based on the previous results presented from our discussion on scientific
virtues, it may not be surprising that the importance of particular virtues
in research was identified as a theme since this topic was a frequently
discussed amongst participants. Participants generally felt that some
virtues are more important than others and several of them directly

emphasized or used examples to illustrate the importance of a particular virtue.

> P9: To me, the real virtue can be really, for example, honesty. That is the most important virtue, but for you, it can be completely different.

When asked to clarify, the participants clearly indicated that research could be conducted without some of the virtues but not without ones that are crucial for responsible research. These explanations suggest that scientific virtues can be ranked by their importance for conducting research.

> P16: It's tricky … I mean, I think if I had to choose between, let's say honest and curiosity, I would choose honesty.
> P15: Yeah, me too.
> P20: Well, let's put this way, the lack of those [honesty and transparency] clearly make a lot of more damage than the lack of others. You can have research without curiosity, ok it's not particularly [group laughter] damaging anyone, but a dishonest research is a different story.

During discussions, participants most frequently pointed out honesty as the most crucial scientific virtue. Accountability was also recognized as one of the essential virtue, as well as reflexivity and respect. In addition to these virtues, the most mentioned virtues important for research, according to the participants, were collaborativeness, curiosity, trust, compliance, integrity, perseverance, transparency, creativity, humility and objectivity.

> P5: I think that we already identify honesty and that's a really all-encompassing one, but I think that it's also very important the, the, accountability.
> P18: I would say, um, one of the virtue would be reflexivity as a researcher.

Respect as an important virtue was clearly demonstrated even during the discussion. When asked to describe the exemplary researcher, a younger participant just pointed to his older colleague, showing that they respected their older colleague as a researcher.

> Facilitator: How would you describe exemplary researcher? Someone that you can show as an example to everyone.
> P20: Looks like we all know him. It is one sitting here [points to P19].

The importance of particular virtues for different scientific fields and disciplines were also discussed. Participants believed that the most important virtues are generally equally desirable in all disciplines, but they also saw that the consequences of not being virtuous could be different in various scientific fiends.

Facilitator: Do you mean, um, different virtues should be stimulated accord-ing to the different research fields?

P7: Probably there all pretty much the same, the core ones, but there will be difference, of course.

P10: If I fabricate research on, I don't know, archeology, does it actually matter? Whereas if I fabricate research that leads to the medical treatment – it has more direct consequences.

P20: I mean, I suppose if you're studying, you know, dinosaurs or some sort of that. You know, you could cheat about your research, but clearly, that's a problem of integrity and so on. But the consequences on other human beings are probably very limited. But if you're doing medical research or if you're doing all of social science research, then, then it's a different story.

Discussion

This study aimed to explore researchers' understanding of virtues in scientific practice and how virtues can be taught in ERI training. The qualitative analysis results revealed the relativity of virtue meanings since our partici-pants expressed different understanding of the concept of virtue, which represented an abstract idea that was quite difficult to define for them. These understandings were influenced mostly by different sociocultural con-texts since virtues are acquired through social interactions. Need and means for improvement of scientific virtues acquisition were identified by the participants, who also emphasized that some virtues are more essential for education on good research practice than others.

One of the core questions we wanted to address was what virtues mean in scientific practice to researchers. The participants in our study under-stood virtues in various ways, from traits defined by upbringing to moral norms or acts of self-reflection. Some of them explained the generic term with the characteristic of a particular virtue; others described them as the absence of vices, which are their antonyms. This is not surprising since almost all great thinkers from ancient Greece to the present day differ from each other in how virtue should be defined. Socrates, Plato, Aristotle, Saints Augustine, Thomas, Kant and many others gave us different and incompa-tible lists, theories and rankings of the virtues which demonstrate the near impossibility of any agreement on virtue meanings and understandings (MacIntyre 1981; Carr 2008; Thornburg 2000). Moreover, even some agree-ments on virtues' characteristics achieved during our discussions often led to the relativity of the meanings. For example, the participants generally identified virtues as something good or positive, but they also emphasize that something commonly considered positive can also be perceived as

something negative and vice versa. As an illustration, one participant mentioned that too much creativity could result in data fabrication. In other words, too much virtue can lead to something opposite. This could also be understood in the Aristotelian view on the golden mean or middle position. Aristotle understood virtue as the midpoint between two extremes, which he called vices. In that sense, virtue is a position between the extreme of excess and the extreme of deficiency (Aristotle, Bartlett, and Collins 2012). In this case, creativity is a virtue between the two extremes – of fruitlessness and fraud. Fruitlessness is a deficiency of creativity, while fraud is an excess of creativity. This relativity of virtue understandings also echoes the finding in Shaw and Satalkar (2018) qualitative study on researchers' interpretations of research integrity. While some participants saw integrity primarily as a virtue, others saw it more as an attitude or an action, but even within each of these views, participants said that they meant several different things to themselves.

Relativity of virtue meaning can also be illustrated by the suggestions from several participants that it is possible for a person to be honest but still not considered virtuous. A good example is research that has honestly reported data, results, methods and procedures but is not ethical in the aspects of the justification of research because it was done, for example, in ways that harm animal or humans subjects. Unfortunately, many examples of unethical research on humans, such as Nazi hypothermia experiments or the Tuskegee Syphilis Study, are well known and documented (Berger 1990; Fairchild and Bayer 1999). Vice versa, something opposite of virtues, such as dishonesty, could not be seen as a vice in some cases since interpretations of someone's behavior as positive or negative also depend on external circumstances and internal motivations for acting in a particular manner. For instance, behavior perceived as dishonest can be, in fact, just an honest mistake if it is not committed deliberately. Since most of the publication retractions do not distinguish honest mistake from misconduct, it is crucial to raise awareness of this distinction among scientists because false accusations can do much unnecessary harm to researchers and discourage others from proposing controversial hypotheses or using innovative methods (Resnik and Stewart 2012; Wager and Williams 2011).

Furthermore, some participants in our study suggested that, in certain instances, dishonesty can even be considered a virtue. In order to give an example of a different interpretation of honesty, one participant pointed out something that we can perceive as "white lies" or lies that can be understood as something positive because others benefit from that dishonesty. They are usually told to be polite or stop someone from being upset by the truth. Some studies indicated that this behavior sometimes occurs in clinical practice because healthcare professionals do not want to bring despair to their patients (Nasrabadi et al. 2020; Sarafis et al. 2014). These relative

understandings of virtues are further complicated by false pretending of being virtuous, which one participant described as virtue signaling. Although this phenomenon is also known by other names, such as moral grandstanding (Tosi and Warmke 2016) or humblebrag (Wittels 2014), it mainly describes those acts that demonstrate one's moral righteousness to gain acknowledgment from others, usually without any honest intentions. Orlitzky (2017) argued that this replacement of genuine integrity-based decision making with virtue signaling has a profoundly destructive effect on many social institutions because it involves the role-playing of emotions and other inner reality that further disconnects the decision-makers from their true emotional self. It is not hard to imagine that the independent development of virtue meanings and understandings could be permanently lost for those involved in such behaviors.

Our findings showed that one of the reasons for this relativity of meanings and understandings is the influence of different meaning-making contexts under which the participants understand virtues. Religious context is one of them, as some participants associated virtues with religion from which people derive their moral principles, and others saw virtues without any religious meaning as a part of universal morality. This idea that religion fosters an "ethos" in which traditional moral values are respected has a long-standing tradition in Western thought (Cottingham 1994). The effects that religion has on the development of social norms and values are thoroughly analyzed in social sciences, especially in the work of classical sociological theorists Émile Durkheim and Max Weber. In *The Elementary Forms of the Religious Life*, Durkheim noted that most religions provide a unified system of beliefs and practices which unites societies through the creation of collective consciousness and ensures social stability (Durkheim and Fields 1995). On the contrary, Weber (2005) understood religion as an accelerator of social change. He argued that Protestantism had a significant impact on modern capitalism development because the Protestant work ethic appreciated the virtues of diligence and thriftiness, which eventually overturned traditional Christian values of poverty. Although this theory remains controversial until today, there is also more contemporary evidence that religious order promoting hard work and thrift could impact economic development through cultural change (Andersen et al. 2017). Furthermore, some recent studies indicated that religion has a role in the determination of different value systems, attitudes and behaviors (Pew Research Center 2016; Costa and Goodwin 2006; Hope and Jones 2014), as well as that religion can affect certain virtues (Geyer and Baumeister 2005; Schnitker et al. 2017).

In addition to religion, the relativity of virtue understandings could also be influenced by broader cultural differences. Moreover, it seems that culture plays a significantly greater role in this then religion. Analysis of

the World Values Survey about personal values showed that the influence of the shared national history is much stronger than the influence of global religions (Minkov and Hofstede 2014). Similar results have also been found in the study, which analyzed the influence of religion and nation on the conceptions of virtues. The importance ratings of virtues between the Northern and Southern European countries showed much larger differences than between Muslims and non-Muslims within the same country (van Oudenhoven et al. 2012). Another study focused on cultural differences of virtues conducted in 14 countries also found strong evidence for correlations between blocks of culturally related nations and the perceived importance of numerous virtues (van Oudenhoven et al. 2014). Hence, it is not so wrong to assume that the relativity of virtue meanings found in our study could be influenced by different sociocultural contexts under which individuals meaningfully shape and develop virtues as an integral part of themselves with the inevitable consequence of discrepancy in interpretations and understandings of some virtues.

The participants generally agreed that virtues are not inborn human quality, which means that they are acquired through social actions between individuals or groups. This is in line with the studies and theories from developmental psychology, which suggest that moral character and virtuous behaviors are developed through social interactions (Clement and Bollinger 2016; Nucci and Narváez 2008; Wang et al. 2016). Furthermore, socialization was recognized by our participants as a necessary and continuous process in which individuals acquire virtues. Socialization is usually understood as a process of learning through which individuals are gradually taught to accept society's beliefs, norms, and values to become effective members of a given society. This process involves a number of different agents of socialization, such as families, schools, peer groups and mass media (Giddens 2009; Turner 2006). Participants in our study especially emphasized one of these agents of socialization – education – as highly important in the acquisition of virtues. Previous studies indicated that virtuous character education clearly affects students' moral and civic development as well as academic achievements (Baehr 2017; Berkowitz and Bier 2004, 2007; Hershberg et al. 2016), so we can assume that the same applies to virtue-based education in research ethics and research integrity.

Our study participants considered mentoring crucial for the acquisition of scientific virtues because students often see their mentors as role models and try to emulate their behaviors. In scientific research, mentors provide guidance not only for the intellectual development and technical expertise, but they also teach students about research norms and ethical responsibilities, which means that they can demonstrate examples of different scientific virtues through their actions (Macrina 2014; Shamoo and Resnik 2015).

Research has shown that effective mentorship has a large and necessary role in promoting research integrity since it shapes early-career researchers' views on good research practice, and reduces their engagement in problematic behaviors (Anderson et al. 2007; Gray and Jordan 2012). Nevertheless, that also depends on a particular mentor since they can "influence behavior in ways that increase and decrease the likelihood of problematic behaviors" (Anderson et al. 2007).

Although participants in our study saw the lack of proper education as a reason for poor research practices, some remain skeptical about the effectiveness of formal ethics courses and training. They pointed out that several studies have shown no positive impact of research ethics education on ethical behavior (Funk, Barrett, and Macrina 2007; May and Luth 2013; Plemmons, Brody, and Kalichman 2006). However, these findings have been questioned by recent studies. A meta-analysis of the effectiveness of interventions in research ethics training concluded that effects on reducing research misconduct are uncertain due to the very low quality of evidence (Marusic et al. 2016). Furthermore, the findings of another meta-analysis on the effects of scientific ethics education showed sizable benefits to participants and considerable improvement within the last decade (Watts et al. 2017).

Aside from education, one way of promoting research integrity is policy enforcement, also known as compliance (Resnik 2012), which is identified by our participants as one of the main aspects of acquiring the virtues. Although compliance is usually viewed as a central part of the principle-based approach to research ethics (Resnik 2012), DuBois (2004) argued that compliance could become a virtue like honesty if researchers saw it as something they do voluntarily in order to protect participates and the aims of the research. Participants in our study suggested that compliance with social norms and rules of research could influence the process of virtues acquisition since researchers who follow the rules are more likely to be virtues. This is in line with Kant's deontology since he believed that we could become virtuous as a result of acting from duty or by following moral rules because we can eventually start to take pleasure in this action, which will, in the end, strengthen our will for a continuation of that behavior (Kant and Wood 2008). Snow (2016) also argued that the unconscious acquisition of virtues through repeated practice in moral actions could become integrated components of character. In the Aristotelian tradition of habituation, she underscored "pathways in which ordinary people might acquire virtue through pursuing valued life goals".

The relativity of virtues understandings and their acquisition through social interactions may have several implications for virtue ethics education of researchers. If a virtuous act for one person may not be virtuous for another, virtue is relative to capabilities, resources, and situation of each

person (Chen 2015), which in consequence prevents easy or universally applicable answers to how one should educate for virtue (Athanassoulis 2014). Any endeavor of a uniform approach for virtue-based education will probably be inadequate in many contexts and so should certainly vary (Chen 2016). Although this can imply a notion of moral relativism and subjectivism in which moral judgments are solely a matter of personal opinions or tastes, the idea here is simply that moral choices are responsive to the circumstances in which individuals find themselves (Sherman 2005). As Aristotle notices, a virtuous act is inextricably linked with adequate social context since, for example, courageous need the right circumstances to demonstrate their heroism (Aristotle, Bartlett, and Collins 2012). Similar, MacIntyre (2007) also claims that virtues are learned and developed in a social context by practicing being virtuous through our relationships with others. Since the performance of virtues is co-constructed socially, we need to know the context and social actors' reasoning for their actions to evaluate their virtue (Moulin-Stożek 2019). This is in line with social constructionist views of reality that emphasize the construction of society, including ourselves, through social interaction. Berger and Luckmann (1991) saw this as a matter of "habit" since any frequently repeated action becomes cast into a pattern that can be performed in the same manner again in the future and with the same effort. From this perspective, learning is considerably context-specific since the sociocultural context has an impact on what is learned and how people learn as a part of participation in cultural practices (Dudley-Marling 2012). In this respect, scientific virtues are not something that can be taught or generated only through verbal instruction, they must be developed through repetition and practice until they become habitual (Curren 2005; Pennock 2019). However, training in virtues should not be based on the mindless drilling in mechanical routines, but rather on the cultivation of particular natural human capacities and sensibilities for ourselves and others (Carr and Steutel 2005a). This can be achieved by teachers or mentors who must themselves demonstrate the virtues they seek to impart in their students through discussions and debates, enabling them to discover moral answers on their own (Athanassoulis 2014). Due to the relativity of virtues understandings where the precise separation between them is not always clearly distinguished, these educators should not teach virtues as specialized domains that exist side by side but rather as overlapping traits that complement each other (Kent 2005).

There are several ways how can this process of virtues acquisition be improved, according to our participants. They emphasized that the currently dominant ERI training approach should be updated with more effective teaching methods and tools, such as learning from examples, case studies, or ethical dilemmas. A vast body of research on example-based learning specifics provides evidence that this learning method is

advantageous in initial cognitive skill acquisition (Renkl 2014). Previous findings on the instructional method's characteristics revealed that more successful research ethics programs included case-based activities, interactive participation, and practice of ethical decision-making skills (Antes et al. 2009; Todd et al. 2017). According to our participants, the acquisition of scientific virtues could also be improved using a combination of the principle-based and virtue-based approach. Palmer and Forrester-Jones founded that discussion on ethical dilemmas and case studies developed from real-life situations enabled researchers to assess their reactions, both from a character-focused viewpoint and by utilizing a principle-based approach, which helped them to incorporate virtue ethics into their research practice (Palmer and Forrester-Jones 2018).

Participants also identified that using the same cases and examples for different scientific fields and disciplines is problematic since it can decrease students' involvement in ERI training. As research ethics developed mostly within the biomedical sciences community, their ethical principles and definition have been universalized in the ethics codes of research councils, professional societies and universities (Macfarlane 2010). Many researchers in the social sciences and humanities have criticized the extension of these ethical principles to other non-experimental research settings without proper adjustments because their unsuitability has resulted in the imposition of pointless restrictions, inappropriate demands and confusion (Schrag 2011). For example, due to the qualitative research's unpredictable nature, a qualitative researcher and an experimental researcher face different ethical issues. Because of this uncertainty, qualitative researchers depend more on their own values and virtues while addressing ethical issues in the field (Macfarlane 2009, 2010), so research ethics trainers should consider this when choosing examples or case studies for discussion.

Continuous education on good scientific practice was also recognized as an essential aspect in acquisitions of virtues due to the constant changing in ethical principles and newly updated regulations, as well as the inefficiency of a once-in-a-lifetime training. Ideally, universities should provide ERI training for researchers at all levels because these topics should be continually discussed from the beginning of a researcher's career (Palmer and Forrester-Jones 2018). Moreover, some argued that high school students should also learn about scientific ethics to "reduce the challenges for those who teach ethics to graduate students" (Eisen and Berry 2002). Previous findings also support the importance of periodic rather than one-time ERI training to "counter the often conflicting views and practices young scientists experience in real-life research settings" (McGee et al. 2008).

Several commentators have attempted to identify what virtues might be important in research practice. Pennock and O'Rourke (2017) described traits that scientists should cultivate, primary curiosity and intellectual honesty because of science's specific aims, but they noted that other virtues, such as skepticism, objectivity, perseverance, meticulousness and humility to evidence, also have crucial roles in science. MacFarlane's alternative approach to research integrity focuses not only on ethical rules but also on character development and includes six essential virtues: courage, respectfulness, resoluteness, sincerity, humility and reflexivity (Macfarlane 2009). Pring (2001) noted that virtuous researchers are the product of virtuous research communities that embody virtues like courage, honesty, modesty, humility, kindness, generosity of spirit or concern for justice. The European Code of Conduct for Research Integrity (ALLEA 2017) identified reliability, honesty, respect and accountability as fundamental values and principals of good research practices in order to guide researchers in their work and prevent violations of research integrity. The importance of different virtues in the research area was a frequently discussed topic amongst participants and they pointed to many similar virtues as authors above. Honesty and accountability were most frequently emphasized as important virtues for good research practice by our participants, but they also mentioned other virtues such as respect, reflexivity, creativity or reliability as crucial concerning collaboration, research design and methodology. In general, participants felt that particular virtues were more important than others because some of them are necessary for responsible research, and some are not.

Strengths and limitations

This is the first focus group study with researchers on the subject of scientific virtues in the context of research integrity. Its main strength is a heterogeneous stratified sample, which included participants from different countries, institutions and scientific disciplines. Also, representatives of all major stakeholder groups that take part in the research process participated in both focus group discussions. Another strength of our sample is the equal representation of male and female researchers, as well as the inclusion of participants at different stages of their carrier. Furthermore, participants in our sample were at least moderately experienced with discussed issues as they published on average 18 publications during their carrier (median 5; range 0–100) and more than half of them had training in research ethics and integrity.

Our study also has several limitations. Although the reflexive thematic analysis approach provides detailed patterns of meaning and participants' experiences, this qualitative approach does not allow generalization of findings from the study

sample to the entire population. Another limitation is that researchers from biomedicine and social sciences were over-represented in our sample. Also, stakeholders were unevenly distributed because, in spite of our best efforts, we could not include more than two representatives of funding organizations. Moreover, we included fewer participants than planned since we had some cancelations before focus group meetings. More precisely, we had 21 participants in two face-to-face focus group discussions instead of the planned 24 participants. However, in our opinion, this did not have a significant influence on the quality of this study, mainly because three participants represented multiple stakeholder groups. Since data saturation is not a particularly useful or theoretically coherent concept for sample-size rationales in the reflexive thematic analysis (Braun and Clarke 2019), we instead followed thematic analysis guidelines developed by Braun and Clarke (2013). In terms of a smaller qualitative project, they recommend 2–4 focus groups and 6–10 participants for interviews, so we do not think that our sample size resulted in significant limitations to this study's findings. Nevertheless, our heterogeneous sample included several students, which leaves the possibility that they hold some of their opinions due to the sensitive topic of research integrity and presence of senior researchers. Also, almost all participants were from European countries because we organized the discussions during EU project meetings, which was the most efficient way to include international experts from different disciplines and sectors.

Conclusions

Several conclusions may be drawn from our findings. The relativity of understandings of virtues needs to be acknowledged in ERI training because they cannot be taught separately as coexisting domains but rather as overlapping and complementary traits. Since virtues are co-constructed socially and acquired mostly through socialization and education, their meanings are influenced by different sociocultural contexts, which can cause additional confusion in their understandings. For that reason, a uniform virtue-based ERI training will probably be inadequate and have to be adjusted for different contexts. Also, scientific virtues cannot be acquired through verbal instruction alone; they have to be developed through repetition and practice until they become a habit. For that, today's dominant approach to ERI training is not sufficient, and it needs to be improved. One possible solution is integrating a virtue-based approach with a principle-based approach to research ethics, which will allow the use of more involving teaching methods, such as example-based learning, case-studies, or discussions on ethical dilemmas. Moreover, educators should also demonstrate the scientific virtues they seek to impart in their students, mostly through mentoring. Nevertheless, due to the heterogeneous and socially constructed understandings of

virtues, it would be challenging to create a definitive list of the scientific virtues. However, given that our participants identified some virtues as more crucial for responsible research that others, we can conclude that scientific virtues can be ranked by their importance for conducting research. To develop virtue-based training for good research practice, it is necessary to answer which virtues should be stimulated and prioritized in this training program. This study identified some particular scientific virtues but since we used a qualitative approach, the generalization of these findings is limited. We are currently working on a Delphi consultation study to identify which scientific virtues should be prioritized in ERI education and training.

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Appendix A. First focus group discussion guide for stakeholder consultation on scientific virtues

Focus group round 1

I would like to thank you all for coming to this meeting. My name is_____ from_____. I am conducting discussion groups as part of H2020 project VIRT2UE. We will discuss your experiences and understanding of scientific virtues in two consecutive focus

groups. This will allow us to develop a holistic virtue-based training programme based on evidence because the results of the focus groups will be taken into account directly in the development of the training programme and materials.

We would like to cover these issues in the discussion. Even if you are unsure about any of these issues, your views are still very valuable to us, so please do not feel shy during the discussion. I would like to say that there are no right or wrong answers, we will simply be discussing your views, opinions and experiences; so please feel comfortable to say what you really think.

As we have already told you, your participation in this group is voluntary. Whatever we discuss today will be confidential and used only for this research project. During the discussion _____ will be taking notes and reminding me if I forgot to ask something. However, so that he/she does not have to worry about getting every word down on paper we will also be tape recording the whole session. The reason for tape recording is so that we don't miss anything that is said and these recordings will be destroyed after they have been transcribed. The transcription will be fully anonymous.

Please do not be concerned about this, our discussion will remain completely confidential; we will use only first names in the discussion and the information will only be used for this research project. Is it OK with everyone to tape-record this discussion? It is also important that only one person talks at a time. We will not be going around the room; just join in when you have something to say. Remember we want to hear all your views, so it's OK to disagree with everyone else if you have a different opinion, but please also respect the views of the others here as well. This discussion will probably last about an hour or so. Are there any questions before we start? Let's start.

Introductory round

As an introduction, let's go around so that you can introduce yourselves, and perhaps tell us how are you involved in research.

Topic 1. Understanding of scientific virtues

(1) What do virtues mean to you? (*Possible probes: In which context do you usually hear virtues being discussed?*)
(2) How are virtues related to good scientific practice? (*Possible probes: How can they contribute to the development of good science?*)

Topic 2. Relationship between virtues and research

(1) In order to cooperate with other researchers, do you look primarily at their academic record or do you also try to judge what character traits they have?

(Possible probes: Can you name those character traits?)

(1) Is there any difference between what virtues make a good person and what virtues make a good researcher??(*Possible probes: What are the virtues every researcher should have as an individual and which virtues are crucial for functioning as a member of a research team? Can we asses those traits?*)

Topic 3. Learning of scientific virtues

(1) How exemplary scientific values and virtues can be learned? (*Possible probes: Which virtues should be stimulated in training for good research practice?*)

(2) What would be examples of virtues teaching in relation of good research practice?

Focus group round 2

Okay, so just before we continue the discussion, I'd like to do a brief presentation about the Virtue project just so you get a better information on it and what are we doing in our research.

Presentation

[Presentation of the project, principles and practices of the ECoC and virtue-based approach in ERI training]

Topic 1. Understanding of scientific virtues

(1) What do virtues mean in scientific practice? *(Possible probes: What are the most important scientific virtues?)*
(2) How are virtues related to the principles of ECoC and vice versa?

Topic 2. Relationship between virtues and research

(1) How can scientific virtues shape researcher behavior?
(2) Can you think of a situation in real life research in which the development of virtues would be far more meaningful than setting rules and codes?

Topic 3. Learning of scientific virtues

(1) Would you prefer scientific virtue approach to ethics and research integrity training or a more traditional approach based on codes and rules?

(Possible probes: What are advantages and disadvantages of each approach?)

(1) Do you think different virtues should be stimulated for different sector/discipline? Please explain.
(2) What can trainers do to encourage researchers to integrate virtues into their everyday practice and understand how to act in concrete situations?*(Possible probes: What are the barriers that prevent integration of virtues into everyday practice and concrete situations?)*
(3) How should the virtues be taught in order to make a content more adjust to trainers?

Ending questions

Does anyone have any further comments to add before we conclude this session?

Appendix B. Adjusted focus group discussion guide for stakeholder consultation on scientific virtues

Topic 1. Understanding of scientific virtues

(1) What would you consider as virtues in scientific practice?*(Probe: Is there any difference between scientific virtues and virtues in general?)*(Probe: What are the most important scientific virtues?)*

Topic 2. Relationship between virtues and research

(1) In order to cooperate with other researchers, do you look primarily at their academic record or do you also try to judge what character traits they have?
(2) How would you describe an exemplary researcher?

Topic 3. Learning of scientific virtues

(1) How exemplary scientific values and virtues can be learned?*(Probe: Do you think different virtues should be stimulated for different sector/discipline?)*
(2) What kind of teaching methods would you prefer in order to teach virtues to someone? *(Probe: Would you prefer theoretical lectures, workshops, discussion groups, examples of best practice or some other methods? Which methods you think would be the most efficient)*
(3) Would you prefer scientific virtue approach to ethics and research integrity training or a more traditional approach based on codes and rules?
(4) How should the virtues be taught in order to make a content more adjust to trainers?
(5) How can virtues be assessed?

Appendix C. Questionnaire for participants

(1) What is your country of residence?
(2) What is your gender?
    Mark only one choice.
(a) Female
(b) Male
(c) Prefer not to say
(1) What is your age in years?
(2) In which stage of the research process you are currently active (e.g., research, publishing, policy, research funding) Mark all that apply.
(a) As an academic researcher
(b) As a journal editor (any role, from editor in chief to manuscript editor)
(c) As a peer reviewer
(d) As a member of a research ethics or research integrity committee
(e) As a policy maker
(f) As a researcher in industry or in SME
(g) As working for a research funding or process organization
(h) As a student
(i) Other:
(1) How many years have you been active in this role(s)?
(2) How many publications have you published?
(3) In which discipline(s) do you work?Mark all that apply.
(a) Biomedical sciences
(b) Social sciences
(c) Natural sciences
(d) Applied sciences (e.g., engineering)
(e) Humanities
(f) Other:
(1) Did you ever participate in a research ethics and/or research integrity training? If so, please briefly describe your experience: