Cultural Studies of Science Education 20

Kathrin Otrel-Cass
Maria Andrée
Minjung Ryu *Editors*

Examining Ethics in Contemporary Science Education Research

Being Responsive and Responsible

Springer

Chapter 7
Challenging Existing Norms and Practices: Ethical Thinking at the Science Education research Boundaries

Jaume Ametller

7.1 Introduction

The five chapters included in this section present different ethical issues that concern science education research. The issues are varied and so are the ethical problems they pose and the solutions that the authors put forward to address them or, at least, to reflect upon them. My aim is not to discuss or summarise them but to suggest common elements which might be useful to help to interpret and to contextualise ethical research problems in science education in a way that is relevant to the new challenges these five chapters exemplify. In doing so, I will lose the depth and richness associated with the particular cases developed in the previous chapters but my goal is to abstract from that richness insights that might be useful in a variety of situations, including, but hopefully going beyond the particular examples of this section.

I will start by attempting to define the nature of these challenges in terms of where they take place. Once I have discussed their nature, I will present some possible sources of those challenges in terms of some constitutive aspects of science education research. Finally, I will propose ways to address these challenges by considering both how we could conceptualise and reflect upon ethical issues in science education research and how we could guide our ethical decisions. Through the chapter, I will advocate for centring our discussion about research ethics on a particular field, that of science education, so that the challenges I discuss, and the ways of engaging with them, will reflect the nature of the network of actors that take part in it (Latour 2007).

J. Ametller (✉)
Department of Specific Didactics, University of Girona,
Girona, Catalonia, Spain
e-mail: jaume.ametller@udg.edu

K. Otrel-Cass et al. (eds.), *Examining Ethics in Contemporary Science Education Research*, Cultural Studies of Science Education 20,
https://doi.org/10.1007/978-3-030-50921-7_7

7.2 The Nature of the Challenges: Individual, Social, and Content Domains

The chapters in this part of the book present a variety of ethical challenges which are representative of the issues encountered in a field as diverse as science education research. Despite this diversity, the issues show some common themes that talk to the shifts in interests and approaches to research in this area. I have grouped these challenges around three foci of ethical issues for presentation purposes but in many cases the research situations in which ethical issues arise involve the interaction of more than one of these foci: issues connected to the social responsibility of research, issues located in the interaction between researchers and participants, and issues connected to the ethical elements of the content being taught.

7.2.1 Issues Located in the Protection of Participants Rights – Individual Ethics

This is the area most commonly discussed in research ethics: how can we ensure that participation in research will not harm participants. Educational research will very rarely entail the risk of physical harm to participants but other types of damage need to be considered, such as those related with participants social exposure (Burbules 2009) and the personal investment on time and effort versus their gain (British Educational Research Association 2018). In the case of education, some of the participants are particularly vulnerable both because they might be children and because research might be focusing on particular groups already socially vulnerable. In any case, researchers must reflect on how participation could put them at risk, and conduct research accordingly to eliminate or minimise such risks.

Once the aims of the research have been established, realizing them is considered by those involved as attaining something worthwhile or beneficial in some respect. Despite this desirability, the process to accomplish those aims must take into account ethical commitments towards the wellbeing of those participating in the research. Research ethics has placed not harming participants beyond any consideration of gains that might be obtained through the research. However, as we have seen so far, and as I will discuss further in Sect. 7.4, the definition of harm in science education research rarely includes physical injury and, in many cases, it has more to do with the idea of respect or avoiding being detrimental in ways that might place researchers in the situation of legitimately wondering if the "greater good" of the expected results does outweigh the disturbance participants might experience. Such choices might entail deciding if informed consent can be restricted so that participants' knowledge does not negatively impact on the research, or whether to adopt an experimental methodology with control groups-even when BERA's ethical code (BERA 2018) suggests otherwise-because the alternative methodologies won't provide results with enough weight to change policy. Issues of this kind have to take

into account socio-political changes, such as the strengthening of the accountability culture, and socio-cultural changes on how identity and agency are constructed and enacted and, hence, how this affects what must be understood by harm and to what extent individual participants can make decisions on these issues.

Issues connected with the impact of research on participants are often connected to the research methods being used and the relationship between researchers and participants (chapter by Allison and Vogt this volume). Measures taken often have to do with methodology, but in the cases where some kind of relationship is established as it is often the case in qualitative or mixed methods research, "non-methodological engagements", i.e. situations of interaction outside the commonly understood and agreed research situations, must also be carefully considered. Partly the problem, as we will discuss, has to do with how researchers and participants see their interaction in different moments as wither part of the research activity, hence subject to research agreements, or as part of a personal relationship ruled by other codes of conduct, which might or might not be shared, but which have usually not been discussed or agreed upon.

Research methods involving video data, information from social media, or internet mining will likely collect information connected with how "identity" is socially defined now. These technologies have a particular impact on issues connected to personal interaction. Visual methodologies are hardly a novelty in science education research, but visual data is more easily collected, edited, and distributed; this ease has fundamentally changed the relation of individuals with video data of themselves (Ametller 2008; Derry et al. 2010). The relation of participants with data, including visual information on themselves, have changed in the past years when this media has been widely socialised as a way to express and construct personal identities (Adami and Jewitt 2016). Ethical questions around anonymity and privacy are part of wide social discussions which reframe the research ethics discussion around these issues. On the one hand, measures to be taken might have to be more stringent because of how easily this data can be distributed but, on the other hand, participants are likely to be more informed about the use of images and to have more agency on the use of their images, which might entail repositioning the researcher's role from one of protector to a more equal standing, one more akin to negotiation than to overprotection.

Networked technologies are more novel than audio-visual technology in educational research and some of the issues they generate – for example, the consideration of anonymity in contexts where participants are users of social media (British Educational Research Association 2018; Burbules 2009) – are not yet well understood and appropriate, normative or accepted ways to address them are not established. Some of these issues are connected with the new uses of visual data mentioned before but also create other challenging situations. In a hypercultural society (Han 2018) the presence in the network of both individuals and institutions can be a source or research data and also an important part of someone's identity. This generates new issues related to what can be used as data and how to obtain permission and because interest on how learning happens in the continuum of time and space (including hyperspace) those are issues that will likely become more

prominent in ethical discussions. Networked technologies also make social networks relevant when considering the impact of participation in research and how this can be perceived outside the group of direct participants (chapter by Ryu this volume).

7.2.2 Issues Connected to the Social Responsibility of Research – Social Ethics

Science education research does not only concern those directly involved in a particular study. It is a social activity with a structure intertwined with other social actors: schools, universities, education policy-makers, funding bodies…. These actors influence science education research practices in different ways. Some of them are aiming at the research activity per se (defining aims, restricting access, directing funding, etc.), others affect research more indirectly (university appointment procedures, educational policies, curriculum reforms, teacher training programmes, etc.). As a whole, they constitute a network of multiple agencies that shape science education research. Negotiating this network also involves ethical issues (see chapter by Johansen and Anker this volume). While the above section has focused on ethical issues more directly connected to individuals, this part looks at issues primarily connected to the social dimension of science education research and its relevance (chapter by Gimmler this volume). I will focus here on the relationship between social responsibility and care for individual participants when deciding to what extent the greater good of research results might justify some aspects of how research is conducted.

Over the past few years, a fundamental issue for social sciences researchers has been the accountability of their work. Mostly, this means being accountable to those who are funding and or supporting our research, either directly or indirectly. This implies that there can be an economic measurement of the value of research which then justifies the influence of those providing the funding on what is being researched and, in some situations, what is reported about it, when and how. These issues affect an important part of research ethics, i.e. the independence of researchers. Ethical problems arise from the fact that extreme positions on this question would either undermine the credibility of the research undertaken or make it impractical to pursue. Researchers must retain a degree of independence but recognise, both for themselves and when sharing their work, the influences that have affected them in their work. Such influences do not need to be seen as a lesser evil, but actually as a normal consequence of being part of a network which makes it possible to affect others in the network, i.e. to make it possible for research to have an impact on teaching practices. Being part of the network also means, that there will be tensions, for instance, around the aims of a particular activity (Engeström 2015). The negotiation on the aims of the research starts even before contacting possible participants. Are these aims included in the funding programmes available? Will these aims lead to outputs that are perceived as valuable by employers (i.e. will I get a job or a

promotion at a university because of the particular research I have conducted)? Should the aims be aligned with policy or should it be connected to issues perceived as valuable by schools? How much influence should one allow to make a relevant contribution while retaining independent judgement? How much control over the results must one retain? Should aims be negotiated with participants? If so, where is the balance between respecting agency and upholding one's professionalism?

7.2.3 Issues Connected to the Nature of What Is Being Taught in Science Education – Content Ethics

Contents touching upon ethical aspects of science as an activity and of science as part of social debates with ethical ramifications have become more present in schools due to the orientation of curricula in recent decades. While this is not research ethics per se, it touches upon the two previous types of issues. On the one hand, because researching in these contexts is likely to face personal issues with ethical ramifications. On the other hand, because the research methodologies and, more widely, how researchers participate in the activity and their interaction with participants need to be considered including those ethical issues.

Beyond the ethical side of chosen scientific topics (Jones et al. 2010), the choice of topics related to personal identity or believes such as religion (Reiss 2008), or that has to do with students' behaviours such as sexual relationships (chapter by Orlander and Lundegård this volume) might place ethics at the centre of the reflection on the wider social responsibility of science education researchers. In both accounts, researchers might face ethical issues connected to cultural and believes diversity in the classroom.

The three dimensions suggested in this section are similar to those encountered elsewhere in the literature in terms of social responsibility and individual protection (Tangen 2014) but has chosen to explicitly acknowledge the content being taught as a dimension. This choice is motivated by the increasing importance of competences and contextualisation in science education curricula which, coupled with a grooving interest on identity issues, is likely to bring to the fore ethical ramifications of contents being addressed in science teaching. On the other hand, the section has not presented a dimension connected to the researchers and the research community. These aspects will be addressed in the next section as one of the two source of current ethical challenges.

7.3 Sources of Ethical Challenges

In the previous section, I have presented the loci of ethical issues that authors in earlier chapters of this book have noted as being relevant in their science education research, and which could hopefully be useful to locate other science education research. Why are these issues relevant in this area of research now? I propose in

this section two possible answers. On the one hand, *onto-epistemic issues* of science education research, on the other hand, *intrinsic issues* of the field and those working on them, their boundary crossing and boundary actor characteristics. I believe these two sources will help to explain the issues presented in this book but could also be of help to other science education researchers to work with or address these issues.

7.3.1 Ethical Issues Connected to Onto-epistemological Choices

Concepts such as identity (personal, social, religious, technical, national *etc*), and agency and values are important ontologies. The socio-cultural influence in educational research means that these concepts come to the fore in a wide range of research work. Even when these concepts might not be the focus of the specific research, they are likely to be elements relevant to the theoretical framework even when these concepts might be defined differently in different frameworks because these are ontological elements that speak to the fundamental point that education is a social phenomenon. Therefore, while these terms might be associated in educational research, if loosely, to post-modernist philosophical takes they would also be relevant in, for instance, new-realist approaches where aspects such as identity or agency can be seen as emergent characteristics of a particular social assemblage (DeLanda 2006).

These ontologies are linked to the focus on social interaction in educational and sociological theories that are prevalent in the field. This theoretical focus is connected with a wide use of research methodologies that require the personal interactions between researchers and participants which, as we have seen in the previous section, involve situations that might entail ethical challenges. Therefore, ontological commitments might introduce in our research ethically sensitive elements that are connected to epistemological choices, and epistemological choices are connected to methodological practices which bring about situations that might entail ethical challenges. For instance, the inclusion of identity as an ontology, even if it is not the focus of the research, is likely to be associated with an interpretative framework of science education teaching and learning as an activity which will take into account the relationships between individuals in social contexts. These interpretative frameworks are likely to be associated with data, and the methods used to collect it, which might introduce in our research practice information deemed sensitive. Even if we don't want it, we have "asked" for it, we have it now, and is a part of our broader interpretation and, hence, we need to deal with it ethically. The choices we make on the ontologies we consider relevant shapes how we intervene, engage and interact with the sociomaterial system we are researching in a way that we are *diffracting* (Barad 2007) the information from that system, showing some aspects of it and not others, because of our particular intervention. We are ethically responsible for both what we choose that matters and what we exclude from our account.

While onto-epistemological elements provide insights on the topics around which research ethics issues will arise, to better understand the nature of the ethical challenges faced by research in science education as an activity, we need to understand the network that gives rise to it. In the next section, I will focus on how the network of social communities and practices shape the characteristics and practices of science education researchers and how these can help us understand some of the ethical challenges we have discussed so far.

7.3.2 Science Education Researcher as a Boundary Actor

Science education research is often described as an interdisciplinary field (Sjøberg 2007) but I would argue it often resembles more of a frontier difficult to inhabit because it stands between areas with little or no overlap. From its foundations, science education research has searched for inspirations in both the science camp and the psychological and education camp. While the field has been successful at generating humble theories (Cobb et al. 2003) that provide useful constructs to understand the process of teaching and learning science, it has not generated a theoretical framework that brings together the original sources of those fields and this is probably as it should be because these are fields with important ontological and epistemological differences. The result is that knowledge and values from areas with little overlap are part of the research and practices in science education. The literature on boundary crossing and boundary objects provides a useful framework to explore this (Akkerman and Bakker 2011).

From its definition by Star and Griesemer (1989), boundary objects are information or objects used differently by different social communities. Aside from boundary objects, we can also consider boundary actors which are "politically motivated actors who manipulate social processes across communities and whose reflexive actions inhibit boundary objects individuals (Star and Griesemer 1989). We use the concept "boundary actor" to denote the individuals who mediate between incommensurable paradigms in the context of power inequalities (Keshet et al. 2013, p. 668). I suggest that science education researchers can be seen as boundary actors operating in a network of relations among school, university, and often policymakers, communities.

On top of the boundary aspects of the practice of science education research, science education researchers are often professionals with a double background, in experimental sciences, in social science research and, in many cases, in teaching. This diverse background is part of their identity, a multifaceted identity that means that researchers might find themselves in contradictory roles in research settings. It is common to play the card of being an educator to gain access, but that might be at odds with the aims as a researcher. This multifaceted identity does not only have the potential to generate challenging situations with participants but also self-conflicting situations for the researchers. The fact that this boundary identity is at the heart of

some of our ethical problems is probably not unique to science education but is probably best addressed by placing this ontological characteristic at the basis of our ethical reasoning.

I want to stress that science education researchers as boundary actors do not only mediate among "external" communities but also mediate among their own "internal" communities. They have boundary identities which allow them to be boundary actors but often those "boundary identities" are conflicting and instead of creating a "mixed identity" generate multifaceted identities that can show individual sides to external actors. The connection of the transaction of those "mono-faceted" presentations with the rest of the (necessary) internal identities generate research ethics problems related to how researchers present themselves to each of the social communities they are part of, or interact with, as well as ethical problems connected to the researchers' decisions on the work they choose to do which might hold different value in different communities.

Often the challenges connected with frontier characteristics of science education research and researchers are also connected to power relations established in research settings. There are several ways in which these power relationships can manifest in science education research for instance on gaining access to participants, practice settings and data. A particular relevant way in which power relations can relate to ethical issues is the establishment of the research aims. Research funders, university policies, and political priorities play a role on the definition of these aims and are all part of the boundary character of the researcher as an actor but for our discussion, we will focus on how they are dealt with by researchers and participants. This involves, at a basic level, the need for informed consent but it often involves some sort of negotiation with the participants in co-constructing some aspects of the research. In doing so, questions of power over the activity and of whom the research will benefit are negotiated.

We can find in the literature (see chapter by Ryu this volume) specific examples of how ethical challenges generated by conflicting aims in the co-occurring practices on science teaching and learning and science education research were addressed through different ways of sharing power. Most of the time this involves negotiating with participants some decisions to do with the planning, conducting and reporting of the research. This runs several risks and, finally, is problematic because those are solutions that, as the discipline itself, often try to find common ground where there isn't and hence the solutions fail at bringing together different perspectives, aims, knowledge or values and, instead, the outcome is usually a de-professionalization of researchers or a shift towards innovation rather than research. The former might happen if the researcher decided to address ethical challenges by reaching a consensus with the participants on how the research will be conducted instead of assuming the role of the expert in research. The later can be a consequence of constraining research designs to ensure that participants will benefit from taking part in the research. I see the reticence to use experimental designs with control groups as an example of this which might constrain the scope of more fundamental research.

7.4 Addressing the Challenge: Ethical Thinking and Ethical Decisions

In this section I will present a proposal for addressing these challenges to provide ideas to be applied generally to the discussion of ethical issues in science education research and how to address them. The proposal is aligned with existing ethical codes, BERA (2018) for instance, which advocate for having some guidelines but ultimately considering each case on its own merits and specificities, hence moving on the direction of pragmatic or virtue ethics. However, I will try to make some specific suggestions that are intended to respond to the issues I have discussed in sections 2 and 3.

In the previous section, I have presented two different sources for ethical challenges but it is worthwhile noting that they are often related and that they are not easily dismissed. By pointing out the sources of challenges, and sometimes the reason why those challenges are difficult to resolve, I am trying to show that making ethical decisions as science education researchers will require considering these issues, frontiers and power relations, and while deontological solutions are an unlikely option given the complexity and contextual influence of the situations involved, there is a need for generating guidelines which are centred on the characteristics of science education research.

While the community of education research has produced several ethical codes and guidelines that are widely acknowledged it is not frequent to find research ethics discussed in depth in research papers in science education. This does not necessarily mean that the available guidelines provide all the required answers. A previous chapter in this book (chapter by Allison and Vogt this volume), for instance, discusses how commonly used deontological guidelines, originally based on bioscience research, are not adequate to address educational research ethical challenges. The rest of the chapters do not explicitly reject existing guidelines but do not directly derive their solutions to ethical challenges from them, rather they provide particular solutions based on their reflections which might, or might not, be explicitly referred to the literature.

To shape our ethical reasoning according to the needs, situations and challenges of science education research we should consider more explicitly the foundations of our ontological and epistemological thinking. This will help us to gain clarity on what are the objects of interest of our research and how we consider we might construct valid knowledge about them. What degree of anonymity, for instance, will prevent us from studying what we need to study?

I have argued before that identity and agency are important ontologies in science education research now. Issues of identity are culturally defined and valued. In hyperreality (Han 2018) this has moved towards a more delocalised, *deterritorialised* in DeLanda's terms (DeLanda 2006), which is accompanied by a drive towards globalisation or increased coherence across our species. This drive is,

however, accompanied but another one that moves towards differentiated, personalised unique identities which are constructed in a self-aware, purposeful way, through a greater sense of agency while also oriented towards social validation. This is to say that while participating in a potentially global network of relations defining identity, each individual is more likely to be different from those close to him or her. This double movement is coherent with the idea of having general guidelines but focusing on contextual discussions since it suggests that the globalisation vector can provide guidelines on the issues we need to consider while the particularised movement is pointing us towards taking also the agency of participants into consideration when facing particular situations.

This way of proceeding might have consequences on how we approach some of the most commonly considered ethical issues. For instance, we might wonder if ways of preserving privacy make sense now when moving from deontology to personal agreement with participants whose agency is seriously considered. Informed consent might also need some different approach. In a society adhering to democratic values we must question how far we need to agree on what we want to do "together" with participants. We risk a form of *enlightened despotism* if we are not prepared to enter a dialogic engagement which is compatible with maintaining different degrees of responsibility for particular decisions to do with the research.

A point of transformation of ethical thinking will be the determination of greater good and aim for science education research which is not shared across funders, actors and participants. I feel that once we reach agreements (local and contextual as well as more generic) on this issue we can move to power relations (and value/aim/methods) negotiations. If participants see their power of providing access in the framework of "greater good" and researchers see their role as experts as a way of securing social value to results the idea of defining worthwhile ethically admissible aims will be easier to agree upon.

Why do we want to reduce power gaps? It is a political aim? Isn't ethics dealing precisely with the existence of power differences where those with the upper hand must act in a way so that this difference in power is not misused? This entails that there might be a power relation that does not represent a misuse of that power. Maybe we should be looking for ways of empowering researchers and participants each in their areas of expertise or responsibility and work towards generating synergies. After all, several of the proposed solutions involve a dialogic perspective and we must remember that dialogue remains creative while differences are respected and maintained. Some authors suggest the use of boundary objects, for instance, a document of initial agreements on the aims and involvement of all actors, or the establishment of a protocol for periodically sharing perspectives on the ongoing activity, that can act as stabilisers of the tensions (Scoles 2018) by providing actors both a common ground of shared understanding and a way of channelling the ethical issues that might appear during the development of the activity and that have not been foreseen in the original agreement.

How research is designed, carried out and reported has to consider the balance of respect for participants' identity and agency as well as for the social responsibility of researchers and the fields – negotiated in a complex dialogue among schools, policy-makers, funders, universities, etc. Keeping this balance, and taking into consideration social constructions of personal identity might push us to move from avoiding harm (a given in educational research) to respecting participants, and then to extend respect from participants to society at large – social responsibility. Is it in the balancing of the different foci of respect that we will encounter issues and responses? And this dialogical approach must be not just a measure of respect for the individuals taking part directly or indirectly, as well as for those who might benefit or be impacted by the research results, it must also be the respect for otherness and this changes our perception of our view and that of our field on science education.

In this section, so far, I have tried to show how engaging with the political and onto-epistemological ideas related to the ethical challenges we face in our research will provide us with guidance for ethical reasoning that is relevant and pertinent to the particular needs of science education research. It does help to reframe the situations we encounter to identify the ethically sensitive issues and elements so we can reflect and prepare guidance for researchers. Since I argue they can often be only guidance its application must be supported by something other than a deontological code. A possible candidate would be "virtue ethics". I am not claiming that science education research characteristics lead to virtue ethics but, rather, that this take on ethics fits with some of the demands that the challenges presented in this section, which can be generalised to a wide spectrum of possible ethically challenging research situations.

A consequence of this proposal would be to transform ethical committees into bodies that, through their discussions can play a role in training ethical researchers. This is important because to apply virtue ethics (Lovibond 2002) implies developing an ethical or moral character which can be, partially, accomplished through being exposed to ethical judgements. Furthermore, the ethical committees should look at border crossing in science education research, which would allow us to reflect upon ourselves as researchers and upon science education research itself.

To face the new ethical challenges, we encounter in science education research general guidelines will not be enough. We must be able to reflect, personally and collectively, upon the nature of those challenges, the issues underpinning them and the responsibility we have as researchers to participants and society at large. We need to see ourselves as entangled with different actors, both direct participants of the research and others who might benefit from it or that shape the research at different levels. This entanglement is not just a way of recognising the participation in a network but the understanding of how that participation changes all the actors, including ourselves, and carries a shared ethical responsibility (Barad 2007). If we do so, I believe that we will not only find ways of conducting our research ethically but, through that reflection, we will deepen our understanding of the field of science education research and increase its impact.

References

Adami, E., & Jewitt, C. (2016). Special issue: Social media and the visual. *Visual Communication, 15*(3), 263–270. https://doi.org/10.1177/1470357216644153.

Akkerman, S. F., & Bakker, A. (2011). Boundary crossing and boundary objects. *Review of Educational Research, 81*(2), 132–169. https://doi.org/10.3102/0034654311404435.

Allison, J., & Vogt, M. (this volume). Reflections on research ethics in historically oriented science education research in Canada. In K. Otrel-Cass, M. Andrée, & M. Ryu (Eds.), *Examining research ethics in contemporary science education research*. New York: Springer.

Ametller, J. (2008). Metodologías relacionadas con la utilización del video en la didáctica de las ciencias. Actas del XXIII Encuentros de Didáctica de las Cien-cias Experimentales. In: *Actas del XXIII Encuentros de Didáctica de las Ciencias Experimentales* (pp. 1270–1283).

Barad, K. (2007). *Meeting he universe halfway*. London: Duke University Press.

British Educational Research Association. (2018). *Ethical guidelines for educational research* (4th ed.). London: British Educational Research Association. Retrieved from https://www.bera.ac.uk/researchers-resources/publications/ethical-guidelines-for-educational-research-2018.

Burbules, N. C. (2009). Privacy and new technologies: The limits of traditional research ethics. In D. M. Mertens & P. E. Ginsberg (Eds.), *The handbook of social research ethics* (pp. 537–549). Thousand Oaks: SAGE. https://doi.org/10.4135/9781483348971.

Cobb, P., Confrey, J., diSessa, A., Lehrer, R., & Schauble, L. (2003). Design experiments in educational research. *Educational Researcher, 32*(1), 9–13. https://doi.org/10.3102/0013189X032001009.

DeLanda, M. (2006). *A new philosophy of society: Assemblage theory and social complexity*. London: Bloomsbury Publishing.

Derry, S. J., Pea, R. D., Barron, B., Engle, R. A., Erickson, F., Goldman, R., et al. (2010). Conducting video research in the learning sciences: Guidance on selection, analysis, technology, and ethics. *Journal of the Learning Sciences, 19*(1), 3–53. https://doi.org/10.1080/10508400903452884.

Engeström, Y. (2015). Learning by expanding. In *Learning by expanding* (2008) (2nd edn, p. 299). https://doi.org/10.1111/j.1440-1746.2006.04459.x

Gimmler, A. (this volume). The relevance of relevance for research ethics. In K. Otrel-Cass, M. Andrée, & M. Ryu (Eds.), *Examining research ethics in contemporary science education research*. New York: Springer Publishing Company.

Han, B.-C. (2018). *Hiperculturalidad*. Barcelona: Herder.

Johansen, G., & Anker, T. (this volume). Science education practices: Analysing values and knowledge when conducting educational research. In K. Otrel-Cass, M. Andrée, & M. Ryu (Eds.), *Examining research ethics in contemporary science education research*. New York: Springer.

Jones, A., McKim, A., & Reiss, M. J. (2010). *Ethics in the science and technology classroom*. Leiden: Brill\Sense. https://doi.org/10.1163/9789460910715.

Keshet, Y., Ben-Arye, E., & Schiff, E. (2013). The use of boundary objects to enhance interprofessional collaboration: Integrating complementary medicine in a hospital setting. *Sociology of Health and Illness, 35*(5), 666–681. https://doi.org/10.1111/j.1467-9566.2012.01520.x.

Latour, B. (2007). *Reassembling the social. An introduction to actor-network-theory*. Oxford: Oxford universtiy press.

Lovibond, S. (2002). *Ethical formation*. Cambridge: Harvard University Press.

Orlander, A. A., & Lundegård, I. (this volume). Sex education – Normativity and ethical considerations through three lenses. In K. Otrel-Cass, M. Andrée, & M. Ryu (Eds.), *Examining research ethics in contemporary science education research*. New York: Springer.

Reiss, M. J. (2008). Should science educators deal with the science/religion issue? *Studies in Science Education, 44*(2), 157–186. https://doi.org/10.1080/03057260802264214.

Ryu, M.-J. (this volume). Ethical considerations in ethnographies of science education: Toward humanizing science education research. In K. Otrel-Cass, M. Andrée, & M. Ryu (Eds.), *Examining research ethics in contemporary science education research*. New York: Springer.

Scoles, J. (2018). Researching 'messy objects': How can boundary objects strengthen the analytical pursuit of an actor-network theory study? *Studies in Continuing Education, 40*(3), 273–289. https://doi.org/10.1080/0158037X.2018.1456416.

Sjøberg, S. (2007). Science education: An interdisciplinary field. In K. Tobin & W. M. Roth (Eds.), *The culture of science education* (pp. 95–106). Rotterdam: Sense Publishers.

Star, S. L., & Griesemer, J. R. (1989). Institutional ecology, "translations" and boundary objects: Amateurs and professionals in Berkeley's Museum of Vertebrate Zoology, 1907–39. *Social Studies of Science, 19*(3), 387–420. Retrieved from http://www.jstor.org/stable/285080.

Tangen, R. (2014). Balancing ethics and quality in educational research – The ethical matrix method. *Scandinavian Journal of Educational Research, 58*(6), 678–694. https://doi.org/10.1080/00313831.2013.821089.

Jaume Ametller is a Serra Húnter Associate professor of science education at the University of Girona. He is interested on the design of teaching sequences and materials, on the role of communication in the construction of knowledge, and on how theory informs our understanding of how people learn.