Chapter 4
Science Education Practices: Analysing Values and Knowledge

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4.1   Introduction

In this chapter, we present and apply a tool for analysing knowledge and values in science education practices, and we discuss this tool's affordances from a research ethics perspective. In developing the tool, we use Schatzki's (1996) practice theory as a starting point. From this point of departure, science education research and science education are seen as two different practices. The researchers are embedded in the practices of doing research, while the science education practices are the object of research. Both research and science education practices involve different aspects of knowledge and values. However, here, we focus on researchers' investigation and analysis of knowledge and values in science education practices. While knowledge is a frequent theme in research on school science, values are often treated more implicitly. We see it as important to highlight the salience of investigating values as part of these practices. School science is value based in the sense that it includes contents and ways of working that are meant to contribute to the students' growth, both personally and as members of society. For more detailed perspectives on this topic, see, for example, Roberts and Bybee (2014) or Carlone (2014). Researchers are not neutral when they investigate practices, and they bring knowledge and values into the practices of research in general (Macfarlane et al. 2014) and the interaction with school science practices in particular (Jenkins 2000). As values are often an embedded and unspoken part of practice (MacIntyre 1985), there is a risk that the values at stake and value judgement may be hidden.

Both authors of this chapter have extensive experience with empirical research in Norwegian classrooms and schools, and both have worked as teachers in secondary

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and primary schools for several years. We have transitioned from the role of teachers to that of educational researchers, and thus, become aware of the potential conflicts between different values when analysing school science practices. If the values embedded in the practices are not understood by the researchers, the researchers may present research findings from science education practices in ways that are unrecognisable to the teachers and students. For instance, when researchers present a part of a classroom activity, this can emphasise problematic aspects of the activity at the expense of that which teacher and students find valuable.

In the following, we first outline some research ethics issues connected to our focus on researchers' investigation and analysis of educational practices. Then, we describe our theoretical position—practice theory as a starting point for developing the analytical tool. To illustrate our points, we present an example from a science education study to show how the tool could be used. Finally, we return to the broader field of research ethics and discuss how this analytical tool can meet some of the researchers' ethical challenges by helping the researchers become aware of explicit and tacit knowledge and internal and external values in science education practices.

4.2   Research Ethics: Values in Research

There is a growing interest in studying values in research (e.g., see *Handbook of Academic Integrity*, edited by Bretag (2016)). Denzin and Giardina (2016/2007) refer to respect for individuals, beneficence and justice as common values in qualitative research. However, they critique these values as too narrow, and at the same time, too broad. They are too narrow because they do not cover the field of research ethics; however, as concepts, they can be too broad by becoming what Hammersley (2008) calls vague value commitments. For instance, there are different forms of justice (e.g. social, epistemic and judicial), and as Gewirtz and Cribb (2006) point out, these may be incompatible: The notion of 'treating people justly' can imply different things for different people or in different contexts. For a more elaborate problematisation of justice as a value guiding qualitative research, see Hammersley and Traianou (2014).

Researchers make evaluative (i.e. value) judgements at every stage of the research process, and these may have ethical implications. For instance, they make such judgements in deciding what questions to ask, what evidence to collect and how to interpret and disseminate that evidence (Gewirtz and Cribb 2006; Hammersley 2008). There are also ethical issues that arise from how validity and reliability is handled in research (Fendler 2016). Thus, researchers need to deliberate on the choices they make. Even if these kinds of deliberations and judgements are important components of research and research education, however, there are differences in how ethical issues are argued for and approached (Beach and Eriksson 2010).

In our context, Norway, a precondition for research is that ethical guidelines must be followed. There are rules on the international, national and institutional levels that must be met prior to receiving the necessary approval for research

projects. These rules are made to ensure data privacy, confidentiality and informed consent.[1] Hammersley and Traianou (2011) claim that these kinds of 'technical' rules are not necessarily conducive to qualitative research as they stem from other research fields. At least, these rules do not capture all the challenges that arise when conducting research (Lincoln and Cannella 2016/2007).

One of the challenges is managing the relationship with participants. On the 'technical side,' this includes informed consent. On the 'analytical side', this can mean involving key stakeholders/participants in the analysis, which is a good principle. However, according to Levinson (2010), this kind of involvement is difficult to carry out as practice-based research has a tendency to 'flow' in unpredicted directions. By nature, analytical interpretations are not static, and different theoretical frameworks may be tested and adjusted in the process. Even when researchers involve participants in the analysis and writing of research, the researchers have the knowledge about possible frameworks and perspectives, as well as article genres and requirements. Hence, there is a risk that the researchers will state the 'problems' and 'solutions' for the participants. This easily leads to unclear expectations and roles that will influence the relationship between researchers and participants (Hemelsoet 2014). In other words, conducting research with participants is subject to difficulties in the relationship between researchers and participants.

One way of overcoming difficulties in this relationship involves providing the participants the opportunity to engage dialogically in the research. Aluwihare-Samaranayake (2012) states that it is important to give the participants a voice in a research project:

> [W]hen interpreting spheres of people's lives and community experiences, it is crucial to adhere through dialogue and critical consciousness and through an inter-subjective lens to the principles of respect, beneficence, nonmaleficence and justice to ensure that the research is enabling for the participant and facilitates humane transformation to achieve empowerment. (p. 76)

Even if we agree with this position in principle, however, it is difficult to carry out. Researchers need a thorough understanding of the practices in which their participants are engaged to be able to employ an inter-subjective lens. In a discussion concerning insider versus outsider positions in research, Bridges (2009) claims the possibility for outsiders (i.e. researchers) to understand the participants and their practices through patience, persistence, hard work, empathy and imagination. At the same time, there are good reasons to resist an outsider understanding as it can be perceived as the 'arrogance of those who claim to understand us on limited acquaintance' (Bridges 2009, p. 118). Furthermore, sources of resistance to outsider understanding may be the participants' desire to protect their privacy or even fear of a loss of identity or social belonging (Bridges 2009).

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[1] EU General Data Protection Regulations (GDPR), national Norwegian Centre for Research Data (NSD; http://www.nsd.uib.no/nsd/english/index.html) and National Research Ethics Committees (NESH).

Another challenge is the difficulty of predicting how research results may affect broader social relations and the political implications of such effects (Beach and Eriksson 2010). It is problematic to assume the consequences of the analytical process. Hence, taking part in a research project is 'risky business'. Gewirtz and Cribb (2006) argue that, in addition to being aware of values as part of the research process, researchers have responsibility for the (value) implications of their work. This is especially important since there may not be a clear separation between knowledge production and use of research knowledge (e.g. through planned interventions in a practice), which is often the case in educational research. Gewirtz and Cribb (2006) call for an ethical reflexive approach that include the following: acknowledging and responding to tensions between the various values that are embedded in the research, taking the practical judgements and dilemmas of the practices that are researched seriously and taking responsibility for the political and ethical implications of the research. Hammersley (2008), on the other hand, argues against this meshing of knowledge production and use of knowledge because it is too easily influenced by the researchers' values—and thus, implications of research and even research evidence may become biased. Although we are aware, and see the importance of Hammersley's objection, our position is that research in education will often aim for changing a practice. Therefore, we see it as important to have ways of dealing with tensions between different values. This implies that normative judgements and values in practice need to be investigated.

4.3 What Is Practice?

We use the theory of social practices, or practice theory for short (Schatzki 1996), to strengthen the awareness of how knowledge and normative judgements are intertwined in educational practices. While research ethics has tended to focus on the relationships between researchers and research participants, instead, our approach involves focusing on practice, which opens up seeing activities as bodily *and* mental routines (Reckwitz 2002b) that are made possible but also constrained by structures (Schatzki 2001). Furthermore, there is a normative aspect to practices as they are evaluated by those who carry them out (Schatzki 1996). In this section, we discuss how practices can be understood and what this may mean for notions of values and knowledge.

To say that education is a practice is based on a present debate in the philosophy of education, and to a great extent, this view leans on the work of neo-Aristotelian researchers (Dunne and Hogan 2004). They oppose the idea of education as instruction, and they see the life of schools as an important focus of research. In this understanding, knowledge and values are both embedded in practices and important to study.

The concept of practice has been developed in interdisciplinary practice theory to overcome the actor–structure division, common in social science research (Schatzki 2001). Practice theorists will say that neither an overall structure forcing

people to act as they do nor a totally open, unguided space for acting freely, exists. Rather, some common norms or expectations define humans' actions and are necessary ingredients of certain practices. Schatzki (2001, p. 11) defines practice as 'embodied, materially mediated arrays of human activity centrally organized around shared practical understanding'. According to Schatzki (2001), activity is looser and less structured than practice is. As such, all practices are based on activities but not all activities are part of practice. Arrays are arrangements or ordered sets of entities, and they point towards practices as social order and patterns of activities. However, Schatzki (1996) states that social order is established within a social practice, meaning that the order does not exist as something outside or beyond the practice. Furthermore, Reckwitz (2002a) emphasises the embodied and material part of social practices. When we engage in a practice, we use the body in certain ways and handle different material objects in our material surroundings. To state that human activity is embodied means that actions are performed by the body and thus, include mental and emotional activities (Reckwitz 2002b).

4.3.1 Practices and Values

Schatzki's (2001) outline of practice overcomes the mind–body dichotomy. He states that a practice includes thoughts, emotions and bodily activity. However, the aspect of values is not elaborated on in Schatzki's (Schatzki 1996, 2001, 2013) practice theory. In his book *After Virtue*, MacIntyre (1985) criticises our society and its heritage from the Enlightenment period for separating values and morals from more mechanical descriptions of human activity. MacIntyre (1985) uses the term 'goods', which is equivalent to our use of 'values'. However, we use 'goods' in this section for consistency. His definition of practice is as follows:

> any coherent and complex form of socially established cooperative human activity through which goods internal to that form of activity are realized in the course of trying to achieve those standards of excellence which are appropriate to, and partially definitive of, that form of activity, with the result that human powers to try to achieve excellence, and human conceptions of the ends and goods involved, are systematically extended. (MacIntyre 1985, p. 187)

MacIntyre (1985) highlights the normative aspects of practices, stating that internal goods are necessary to call something a practice. As a result of focusing on the normative aspects, MacIntyre's (1985) outline of practices has been taken up by philosophers of education (Dunne 2003; Hogan 2003; Noddings 2003; McLaughlin 2003), and his definition of practice has been used to emphasise the value dimensions of educational practices. However, MacIntyre (1985) does not regard education as a practice, because he sees education as teaching and instruction. In contrast, in a thorough discussion on the topic, Dunne and Hogan (2004) disagree with what they consider to be an instrumentalist view of education and conclude that, to them, education *is* a practice.

MacIntyre (1985) emphasises that there is a common understanding of what to strive for in a specific practice. Something can either be good and right or it can be wrong. These standards can be seen as the collective aims of a specific practice (MacIntyre 1985). Taking part in a practice means working with others to achieve goals. MacIntyre (1985) divides the aims of a practice into two main categories— external and internal goods. External goods can be, for example, power, money and fame. These can be goods in many practices and are not specific for one practice. Such goods become the individuals' possessions, and the more one has, the less there is available for other people to obtain. For instance, not everyone partaking in a practice can have the same possibility to gain power. In other words, external goods have limits; however, internal goods are realised when trying to achieve excellence in practice. In contrast to the individualistic aspect of competing for external goods, the achievement of internal goods is a good for the whole practice, and thus, such goods are not delimited to individual participants. Internal goods are specific to a practice, and therefore, they can only be identified and recognised by the experience of participating in the practice in question. Hence, '(t)hose who lack the relevant experience are incompetent (…) as judges of internal goods' (MacIntyre 1985, p. 188). Such a statement may be an argument in favour of taking part in the practices that are being studied to fully understand what is at stake.

To support the idea that education can be called practice, internal goods are essential. An example of an important internal good to strive for in the science classroom could be that all students contribute constructively and jointly towards building knowledge, which will improve the practice. Moreover, there are also external goods in educational practices. National and international tests of science knowledge involve ranking schools or countries, and often it is important to be the 'best' because it increases prestige. However, for most, this is an unachievable aim.

MacIntyre (1985) emphasises the importance of institutions for practices' long-term survival. A practice is not the same as an institution, but it does depend on an institution, while an institution simultaneously depends on practices (MacIntyre 1985). For example, science education research can be seen as several different practices. For some of these research practices, the internal goods are improving science education, as well as striving towards excellence in science education research. However, the institution—the university—must ensure that external goods are achieved; for example, they must make certain that articles are submitted to show academic production and secure necessary funds to survive as an academic institution. Hence, there can be a conflict between the aim of the research practice and the institution bearing this practice (cf. Löfström 2016). The same can be said about the practices of science education in schools. Science education strives for better science education, whereas the school, as an institution, must also strive for various external goods. In the rest of the chapter, we revert to the term 'values' instead of 'goods'.

4.3.2 Practice and Knowledge

There are certainly things going on in a science classroom that have little to do with the subject, for instance, quarrels between students, faulty technical equipment or unexpected changes in the schedule. However, in science classrooms, the main activity is dealing with science knowledge. Researchers need to be aware of how knowledge in science education practices plays out—how knowledge is approached, developed and shared among the participants in a given setting (Jensen et al. 2015). This allows the researchers to move beyond what Jensen et al. (2015) call the traditional emphasis on 'knowledge as content' to knowledge as investigative processes, modes of inquiry and principles for verification as components of school activities. This means that there is no strict division between knowledge and skills. In practice as performance (Reckwitz 2012), i.e. when a practice is carried out, knowledge is one aspect of embodied human activity; knowledge can be part of what people think, say and do. In practice theory, material objects can be part of how knowledge is developed and shared. Extending this argument somewhat, a focus on practices allows for the incorporation of tacit forms of knowledge (Collins 2001).

Collins (2010) discusses explicit and tacit knowledge, making an elaborate argument that there are different forms of tacit knowledge, namely, weak, medium and strong tacit knowledge. Weak tacit knowledge passes between participants in a practice when they have enough cultural similarity. It is possible to make this type of tacit knowledge explicit with some effort via, for example, longer and more substantial explanations or apprenticeships (e.g. learning some skill). However, making the tacit explicit may be 'impossible' because this is cumbersome within a reasonable timeframe and the limits of the human attention span. Furthermore, a participant in a practice may not see that some of the knowledge he or she applies is important; the knowledge is not recognised, and thus, it is left uncommunicated. It is also possible that he or she does not see that the knowledge is needed by the other participants, so it is left unsaid. Medium tacit knowledge involves how people perceive and use the body in performing knowledge (i.e. skills). Strong tacit knowledge is collective at the societal level. Individuals share collective social knowledge by partaking in social practices, for example, how to walk on a sidewalk when it is or is not crowded. This view of knowledge has consequences for education: '[E]ducation is more a matter of socialization into the tacit ways of thinking and doing than transferring explicit information or instructions' (Collins 2010, p. 87).

Knowledge inherent in a practice builds on previous practice and includes a historical or traditional aspect of practice. However, some practices, such as teaching and research, are also focused on developing, applying and sharing new knowledge:

> [I]t is also a characteristic of current times that many occupations and organizations have a significant knowledge base. In these areas, one would expect practitioners to have to keep learning, and the specialists who develop the knowledge base to continually reinvent their own practices of acquiring knowledge. (Knorr Cetina 2001, p. 175)

Knorr Cetina (2001) continues by saying that, when a practice aims at developing knowledge, the practice becomes something other than just habitual activities. One

way of developing knowledge in an educational practice is making the aim to improve the practice. According to Turner (2001), the learning of, and thus participating in, some practices purpose relative. We assume that practices like teaching and research are purpose driven in that they seek to improve practices. This implies that these practices will rely on an amalgam of values and knowledge.

To summarise, we see science education and research on science education as practices with inherent aspects of knowledge, both tacit and explicit, as well as internal and external values. These different aspects are intertwined. However, in the next section, we employ an analytical split between values and knowledge in practices for the sake of performing the analyses.

4.4 An Analytical Tool: Practice—Knowledge and Values

So far, we have examined how practices can be understood in terms of values and knowledge. As we have seen, practice theory implicates a broad view on knowledge. A practice's inherent knowledge is both tacit and explicit (explicitly communicated), where tacit knowledge is more elusive because it is not expressed through verbalised language. Besides these different forms of knowledge, values are important aspects of a practice. Values provide participants with reason and direction when working with knowledge (striving for knowledge). In the differentiation between external and internal values, internal values of a practice are the 'real' values, but they are seldom verbalised. While internal values are specific to a practice, external values are common to different practices. Values seem to be quite fixed; MacIntyre (1985) claims, 'In the realm of practices the authority of both values and standards operates in such a way as to rule out all subjectivist and emotivist analyses of judgment' (p. 190). There is a normative aspect of practice that is shared among the practitioners for joint judgement. However, values can be criticised—a not uncommon feature of classroom practice.

Knowledge and values are intertwined and operate on different levels of verbalisation and visibility in a practice. To make it possible for the researchers to differentiate between these different levels, we have developed a tool for the analytical process (see Fig. 4.1). Activities that constitute the practice can be interpreted according to the four categories given in the figure. We emphasise that this

Tacit knowledge & internal values	Explicit knowledge & internal values
Tacit knowledge & external values	Explicit knowledge & external values

Fig. 4.1 Practice as configurations of knowledge and values

analytical tool is made for analytical purposes, so it does not reflect what *is*, but rather, helps in understanding the practice.

For the teacher (or researcher), there may not be a perceived conflict between internal and external values. Different positions on knowledge and values may exist side by side in a practice. The teacher may be explicit on some of the purposes, knowledge and values while not stating others as clearly. In the next section, we provide an example to show how the tool can be used to analyse knowledge and values in educational practices. The main function of the example is generating a starting point for investigating how knowledge and values are intertwined.

4.4.1 A School Science Research Project: An Example for Analysis

Before applying the analytical tool, we want to provide an overview of a research project, as well as an example story. This story is based on various fieldwork notes and interviews from one of the authors, written into one coherent narrative. It is written in first person to gain the researcher's perspective on the fieldwork: This is a story based on the researcher's gathered facts, as well as her thoughts, feelings and actions. A narrative can be a means through which one attempts to grasp the real; it also facilitates the reader's engagement with this particular reality (Watson 2011). The reason for writing a narrative is to synthesise years of fieldwork and include several significant incidents. In this way, we are able to form these incidents into a single story, which in turn, can be analysed in the frame of an article. According to Connelly and Clandinin (1990), the criteria of verisimilitude and appearance trump reliability and validity criteria when presenting research findings through narratives. The truth of the story's timeline is not that important; what is more important is to show how the discussion can be transferrable and useful in other research projects (Connelly and Clandinin 1990).

The example story is taken from an ethnographic project in a science education class where I (first author) spent a great deal of time with the teacher and students. The aim of the research project was to support students' meaning making when engaged in structured inquiries. The teacher facilitated the activities, and the students made and appropriated a broad spectrum of representations, including some traditional (e.g. tables and graphs) and other less traditional representations (e.g. cartoons and photo stories) in school science. The empirical material was analysed using discourse analysis inspired by Halliday and Matthiessen (2004) and Fairclough (2003).

The teacher was experienced, and she expressed an affinity for working with students. She wanted to contribute to their education and 'make a difference'. The students, aged 16 years, were mostly low to medium achievers in terms of the subject matter. They wanted to do well in school and pass their final exam in science that spring, but they did not have a special interest in school science. Most of the

time, the students complied with the teacher's instructions, and they worked together quite amicably.

The following fieldnotes, with questions/comments in italics, are from a lesson where students were instructed to perform two small practical activities in thermodynamics, on the topic of heat:

> The students are stalling in their practical activities. 'What are we to do now?', they ask. Some are doing something else entirely. *They did not 'understand' the teacher's two previous introductions. The question is why? Is the topic of heat not very engaging? Do they understand why they are doing this?* The teacher 'blows the whistle', and for the third time, introduces the practical activities. She provides a detailed demonstration of how to use the equipment. Without being impatient, she asks the students, 'What do you do then?' One or two raise their hands to answer. At the very end, the teacher asks, 'Ok?'; some students say 'yes', some nod and some do not give a visible/audible response. The teacher is very calm. The teacher focuses on what to do; all the verbs she uses are physical actions to carry out the steps in the procedure. There are no verbs that indicate that the students are to try to make scientific observations.

In my view, the students had to interpret the practical activities independently, unsupported by the teacher. There was no emphasis on how to make observations (e.g. 'If you touch the beaker, what do you feel?' or, 'Look at the bottom …') and inferences (e.g., 'What do you think this means?'). In my original analyses of the fieldwork, I found it problematic that the teacher's practice focused on 'doing' and not on 'meaning'. In other words, the goal of *doing science* was upheld at the expense of the other goals, which has been seen as a persistent problem in science education (Hodson 1993; Windschitl 2008; Gyllenpalm et al. 2009). The teacher did little, in my view, to use *doing science* as a starting point to engage students in a discussion on *learning about science* (see e.g. Hodson 2014) and broadening their conceptual understanding of heat. At a personal level, I had (and have) a deep respect for this teacher. However, I felt I had to report what I found problematic in the practice, and I evaluated it as science education with 'some problems'. I pointed to the teacher's somewhat narrow understanding of the purposes and knowledge concerning students' practical activities. The teacher told me that she incorporated practical activities when she thought it was important for visualising some phenomenon or concept, and to her, it was important that the activities were fun and easy to carry out for the students. The teacher sometimes 'complained' about the voluminous and extremely specified national science curriculum, which left her with little possibility to manoeuvre the science subject for students with varying backgrounds in science and little experience with laboratory work.

As these are persistent problems that are frequently reported in science education literature, I may have had a special critical gaze when considering the classroom activities because of my academic training. The problems became visible through the analysis of the verbal communication. However, afterwards, I felt that I had missed something in my account. My hunch was that I had missed some of the unspoken workings of this practice.

4.4.2 Applying the Analytical Tool to the Example

As we discussed above, researchers make value judgements at every stage of a research process. Even if the aim of using the tool is to open up knowledge and values in practices, researchers' use of the tool can never be value neutral. In the example, the researcher judged the teaching and learning situation against her standards of what good teaching practice in science entails. These standards are related to how teachers and students approach, develop and share knowledge. The researcher has developed these standards by reading science education literature, as well as gleaning them from personal experiential context. Clearly, the teacher had standards that were more connected to the context of which she was a part, and her standards were not limited to notions of knowledge. In other words, the valuing processes for both teacher and researcher were strongly connected to their respective experiences. Value judgements often start with what can be regarded as a gut feeling: 'This is wrong', or 'This is good'. To translate this into a more formal language, the researcher used a vocabulary that was taken from the literature. The researcher observed the classroom activities and looked for certain cues (e.g. type of verbs) when judging their quality. Engagement in understanding and judging practice draws on knowledge, emotions and expectations, and it is largely implicit and his-torically–culturally specific (Reckwitz 2002b). The researcher was familiar with these types of translations, especially during the analytical process. This was part of her developed research skills, where the researcher often retrospectively analysed these first intuitive value judgements—and possibly, 'corrected' them. The teacher, in contrast, had to act in the classroom with minimal time to think. While teachers act in the classroom, education researchers describe and analyse their acts. We now broaden the description by accounting for values and knowledge.

The first step on the way to making an analytical description is identifying the explicit and tacit knowledge in the activity. There were several different types of explicit knowledge in the teacher's presentation. She used words like 'heat' and 'heat transfer' when she talked to the students and thus, directed the attention to central thermodynamic entities. By showing and telling, she connected these entities to the use of the equipment. There were also several hints of tacit knowledge in this short presentation. The teacher never explained (to the researcher's knowledge) the importance of following a strict procedure to the students, and thus, she did not clarify the need for students to remember the procedural steps and their sequence. There was no reference to making observations or inferences from observations. That these observations could, and perhaps ought to, be interpreted in terms of general principles was left tacit or implicit. How the entities were to be linked to the students' experiences was not mentioned here, although it was later touched on, at least to some degree. The teacher did not provide reasons or purposes for doing the activity; therefore, it was given no explicit value.

The next step is identifying possible values that are embedded in the practice. When the teacher and researcher spoke about what they saw as valuable in (science) education, there seemed to be meaning alignment. On the surface, the values were

shared; however, the meaning alignment cannot be taken for granted because values are seldom made explicit and clarified. The researcher's interpretation of values relied on her ethnographic field experience, which is more extensive than the sum of her fieldnotes, interviews and videos (Hammersley and Atkinson 2007). Some of the external values in this practice were the explicit notions from the national government and school leadership to raise standards, and specifically, increase the rate of passing grades. This can be characterised as an external value for the school as an institution (i.e. achieve higher grades, be a 'better' school and attract more academically gifted students), although it has a 'twin' internal value: The teacher wanted the students in the class to do well. For the teacher, an important aspect of 'doing well' meant students could master what she saw as the standards of school science. The school administrators' anticipation that more students would pass, was problematised by the teacher and researcher from a 'raise the standards of science education' point of view. The external value (passing) created an incentive for the teacher to 'lower standards' in the sense that she had to compromise on what she thought was valuable. The internal values of this practice were about striving to adopt and adapt to a (school) science way of thinking and acting. What was seen as valuable was remembering factual knowledge and being accurate when doing practical work.

We now use the analytical tool to delve deeper into the example, which provides an opportunity to examine different combinations of explicit and tacit knowledge, as well as internal and external values.

Explicit Knowledge and Internal Values The teacher chose words like 'heat' and 'heat transfer'. She could have chosen other terms, such as 'energy transfer'. Choosing more everyday words can be seen as contrary to the internal value of adopting the 'science way of thinking'. By making this choice, she communicated in a language that was closer to the students' spoken language. Maybe because she wanted them to feel included by not using an alienating language. When the teacher went through the procedure (for the third time), she emphasised the value of following procedures and how to use equipment in science. She wanted the students to remember what to do. The value of remembering could be coupled with the teacher's conviction that all students should be included and able to do the activity. Thus, the students could learn the necessary scientific knowledge so they could adopt vital parts of (school) science. However, as science is a subject where there is a considerable amount of information to remember, the teacher selected the knowledge (within the limitations of the national curriculum) on which she placed particular value.

Explicit Knowledge and External Values In this example, verbalised knowledge had another characteristic: It prepared students for the final exams. This was an external value for both the teacher and students. It was necessary to prepare students for their exam throughout the year, even when it was not explicitly communicated that this was the focus. It was important for the students to achieve good results, and the teacher wanted her students to perform well. Even if seldom explicated, 'good teachers' manage to teach their students so that they achieve 'good results'. In some ways, students achieving good results elevates a teacher's status. For the school,

good grades are important because they may be used to indicate to school authorities that this is a school that did achieve 'the results'.

Tacit Knowledge and Internal Values   The teacher gave no specific reasons either to her students or the researcher about why it was so important to follow the set procedure. It just *was* important. The procedure became a way of tacitly adapting to a (school) science way of thinking and acting. The procedure needed to be followed, but its inner logic was never explained. Moreover, observations and inferences were not really touched on by the teacher, and they were probably seen as aspects that were 'just going to happen'. Perhaps observations became tacit since they were performed bodily and obvious for the teacher (cf. Collins (2010)). The teacher had a strong motivation to let her students experience and feel curiosity and enjoyment when doing practical work. If she were to focus on observations and inferences, some of the valuable curiosity could vanish. This activity had similarities to discovery learning where the results are waiting at the end of the procedure, and these results will be incontestable, see Gyllenpalm et al. (2010) for an elaboration on different traditions in practical work. This activity can be seen as part of the enculturing of students into tacit ways of thinking and doing school science. The internal values, a mixture of wanting the students to be able to carry out the procedure accurately and desiring that they feel curiosity and enjoyment of science, constituted a science subject where knowledge will appear when the procedure is followed correctly. Science became only loosely coupled to general principles: The phenomenon was not seen *as* something.

Tacit Knowledge and External Values   There is another way to understand the values connected to tacit knowledge: If the aim is to teach students so that they pass the final exam, there is no real need to delve into how science works or the importance of observation and inference. In this case, observations and inferences could be left tacit because they were less needed on the exam. As the teacher once said during an interview, '*If the students were able to recall detailed knowledge correctly, the external censor[2] will be impressed*'. This is what the average censor would expect, she claimed. By the students' accurate recitation of core knowledge, the teacher—and students—would probably be considered 'successful'.

To summarise, in this practice, explicit and tacit knowledge and internal and external values were all at play. The practice of science education is a complex amalgam of knowledge and values, which can create problems for a researcher. If a researcher only 'sees' the 'visible' practice and omits values and the un-verbalised, there is a risk that the analysis of the school practice will be too shallow.

We used the tool to explore configurations of knowledge and values. This allowed us to go beyond the verbalised knowledge to study embodied and tacit knowledge.

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[2] In Norway, the final exams have an external censor. The censor is a teacher from another school that assesses the students' performance. If a teacher chooses to do something unconventional in science, this may not be well received by some of the censors.

Internal and external values gave the knowledge in this practice worth. Values contributed to increasing the depth in the understanding of the practice compared with focusing only on verbal communication.

The analytical process had three main stages, each providing the researcher with different forms of insight into the practice. The main stages were as follows:

1. The researcher's initial gut feeling: The lack of meaning and purpose concerning knowledge and ways of working in the activity;
2. Strengthening of the gut feeling through the original analysis of speech acts: No reason was given for why the students should follow the procedure—or indeed, why it was important to do this at all. The analysis also revealed a lack of verbs that could have directed students towards observations and inferences, connecting the concepts in the teacher's introduction with the activity; and
3. Elaborating on the original analysis by applying this analytical tool, considering the values of the practice: In the interplay and conflict between external and internal values (e.g. more students with passing grades and a 'science way of thinking'), the approach to the science knowledge became less self-evident. What should a teacher do to embrace very different values? At the same time, the choices made by the teacher in the practice becomes more complex. Hence, it is easier to argue that the teacher's sayings and doings are highly reasonable.

For the third stage, we open up the different forms of knowledge and values that are intertwined in any practice.

4.5   Ethical Challenges When Analysing School Science Practices

The 'intertwined-ness' of knowledge and values plays a vital part in science education. In science education, there are debates—and sometimes disagreements—about what the most valuable knowledge is and what knowledge students ought to learn. This can be reformulated into visions for what it means to be knowledgeable in school science (see e.g., Roberts 1988, 2011; Roberts and Bybee 2014; Liu 2013). Moreover, the vision(s) for science education can be seen as the goal of tacit and explicit socialisation into the knowledge culture of (school) science. When researchers and practitioners come together, they do not necessarily share the same visions for what it means to 'be knowledgeable', and they ascribe different values to different aspects of the school subject. For instance, for researchers, the value of incorporating aspects of nature of science explicitly when students do practical activities is often seen as a highly important part of being knowledgeable; see Lederman and Lederman (2014) for an elaboration. In contrast, for teachers, being knowledgeable needs to be negotiated with how they perceive their students' interest and their interpretation of the curriculum. Hence, it makes sense to untangle knowledge and values through an analytical process; otherwise there is a risk that the analysis gives

rise to misunderstandings between practitioners and researchers. This position has some ethical consequences for how to approach research.

We are aligned with Gewirtz and Cribb (2006, 2008) and Hammersley (2008) in the view that there is a need to go beyond the technical approaches to research ethics and look into ethical aspects at all stages of the research. The analytical tool makes it possible to identify and acknowledge value tensions and dilemmas that are embedded in practices (Gewirtz and Cribb 2006). When interpretations of practice do not consider what is regarded as valuable in a particular practice, practitioners may not feel that they have been understood (Bridges 2009), and there is a risk that the relationships between researchers and practitioners will become strained. Values are seldom made explicit, and thus, they may be underlying other conflicting issues that cause strain. This strain on the relationships has been discussed in the research ethics literature (e.g. Aluwihare-Samaranayake 2012). However, we do not see the solution to this kind of problem as solely involving improving the relationships between practitioners and researchers. As Bridges (2009) describes, it is possible for researchers to understand a practice through patience, persistence, hard work, empathy and imagination. However, we would emphasise the need for consciously investigating the values that embed the practice, since values are important 'drivers' for choices and actions. For the researchers, to discuss the values in a practice with the practitioners can be one way of validating what is seen as worthwhile, as well as gaining greater reflexivity for all parties. By connecting values to other key elements (in our case, knowledge) one can analytically unravel a complex practice—at least in part.

Hammersley (2008) claims that there is a risk of research bias, that is, for the researchers to produce data and interpret them in ways that are in line with their commitments or prior assumptions. This risk is especially prominent when a researcher's aim is to change or improve practice. As research can never claim to be neutral, it is easy to try to impose one's values when interpreting the practice (Hemelsoet 2014). One way of reducing the risk of bias is through making not only the practices' internal and external values, but also the researchers' values, explicit. The researcher's awareness of own values can mitigate some of the effect of the unpredictability of the analytical process (Levinson 2010) by laying open the communication on important values.

Another problem Hammersley (2008) points out is the problem of scientism in research that aims at changing practices. As he describes it, scientism is a rather narrow understanding of research results and how they can be used to make improvements and affect a practice. Research, he states, can obviously influence a practice, but this should be for the practitioners to decide (Hammersley 2008). We agree that this may be an ethical problem: Can 'we' know what the best changes for a particular practice are? If the intertwined values and knowledge in the practices are not untangled—and the practices' internal values are not acknowledged—there is, as we see it, a great risk that practice will not be improved by the research.

Hammersley and Traianou (2011) argue that the main objective for research is to produce 'sound knowledge', where ethical reasoning is one part of the research process. They warn against approaches to research ethics where values that are

external to the task of producing 'sound knowledge' are treated as if they were central to it. Moreover, in a review on research publications in social science, Löfström (2016) discusses several dangers coupled to publication pressure. This pressure may lead researchers to 'overreport' results, minimise research context and downplay the role of their own values. The researchers' assumptions about social interaction and knowledge production influence the choices of theory, research questions, research methods and avenues for disseminating results. These assumptions involve 'personal and social values that can have moral consequences through the choices and actions that researchers take' (Payne 2000, p. 308). This calls for ways to identify and deliberate on the values that are central to the stakeholders in research projects. We propose this analytical tool as a way of mapping and describing knowledge and values in research practices as well.

4.6 Concluding Remarks

Within practices, there are common norms and expectations for what is said and done (Schatzki 1996). This implies that the aims of a practice give value to what is said and done: The combination of explicit and tacit knowledge is intertwined with what is regarded as valuable. Values are a ubiquitous part of any practice and shape what occurs. By differentiating values into external and internal values (MacIntyre 1985), the intertwined knowledge and values can be made visible. We see it as important to explicitly identify what is—and what is not—valuable. This requires that the views of research as free from value judgements are regarded as 'illusions'; however, it does not mean that 'anything goes': Values need to be made clearer as part of the analytical process. We claim that the entanglement of underlying values and knowledge in science education practice needs to be considered during the analytical process.

We have argued that investigating the configuration of values and knowledge as part of the analytical process can be an element in ethically sound research. More precisely, to conduct 'good research', transforming vague and elusive parts of an educational practice into substantial argumentation is important. Moreover, by emphasising both internal and external values, in addition to tacit and explicit knowledge, the tensions and dilemmas the participants are facing become clearer, and the practical judgements within the researched practices can more easily be understood. Hence, the analytical tool presented in Fig. 4.1, can help researchers become ethically reflexive during the analytical process.

There is a need to explore the usefulness of the analytical tool in other school (science) practices. One possible extension is to emphasise materiality and affective aspects in the practices. Such perspectives are important in education, and they are seen as significant in practice theory (Reckwitz 2012). Another possibility is using the tool as a starting point for exploring political consequences of worthwhile knowledge, and by so doing, avoiding the critique of practice theory stating that it does not put enough emphasis on power and micro-politics (Sayer 2013).

Research and education are two practices with different internal values. The tool presented in Fig. 4.1, can contribute making values in different practices explicit. This is beneficial when the goals of educational research are to critically investigate, and possibly improve, the practice of education while at the same time work for its own internal values. Therefore, opting for ethically sound research means incorporating values into the analytical process as a part of the practice.

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