Chapter 5
Interaction Ritual Approaches to Emotion and Cognition in Science Learning Experiences

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There is ongoing concern internationally about student disaffection with science, technology, engineering, and mathematics (STEM) disciplines. Research focusing on student engagement with STEM disciplines has offered one approach for addressing this concern (e.g., Olitsky and Milne 2012). In this context, science educators such as Stacy Olitsky and Catherine Milne (2012) have sought to study commensurate sociological and psychological constructs of emotional, behavioral, and cognitive engagement in an attempt to understand and ameliorate student disaffection with school science. Paralleling this focus on engagement has been the perceived disconnection between emotion and cognition in studies of science education that have tended to focus predominantly on the latter in the past (Alsop and Watts 2003; Fortus 2014).

Approaches to science education research that draw on perspectives from the sociology of emotion and interaction ritual theory (IRT) may hold one of the keys to understanding and addressing student disaffection. This is due to the emphasis on the interrelationships between social practices, emotion, and knowledge construction made possible by these theoretical traditions. These approaches also offer scope for addressing the study of emotion and cognition in integrated ways.

The remainder of the chapter is divided into three major parts. In Part 1, I present a discussion of studies offering a foundation for understanding science learning through the sociology of emotion and interaction rituals. I will discuss Randall Collins' (2004) theory of interaction ritual chains, which brings together emotion with social practices at a microsociological level. This theory has been adopted in an increasing number of science education studies that have yielded fruitful understandings about what it means to learn science in school settings (e.g., Milne and

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Otieno 2007) and what it means to become a science teacher (e.g., Rinchen et al. 2016). In Part 2, I trace the roots of interaction ritual theory to its origins in Durkheim's (1915/1964) social epistemology of knowledge and sociology of religion. My elaboration of Durkheim's social epistemology of knowledge paves the way for my final argument for a microsociology of learning in Part 3.

5.1 Part 1: Sociology of Emotion and Interaction Rituals for Science Education Research

Studies in science education adopting theoretical perspectives from interaction ritual theory and sociology of emotion presented in Part 1 of this chapter reveal common views about learning science or learning to become a science teacher as socially situated practices (e.g., Olitsky 2007). Within these perspectives, embodied actions, emotions, and cognitions are treated as interrelated phenomena. Learning science thereby involves a process of growing participation in group activities focused on common science practices, science/science teaching objects, symbols, and ideas (Olitsky 2007; Bellocchi et al. 2014). These elements are important to the wider science community (i.e., scientists, curriculum bodies, educators) because they represent canonical knowledge and practices within scientific disciplines. From an interaction ritual perspective, however, the same elements must gain salience within small groups such as school or university classes, if learning experiences are to be successful. In addition to adopting accepted practices and symbols, the creation of science symbols, ideas, practices, and objects is another important aspect of learning science from this perspective. Evidence of learning in the studies I will discuss in Sect. 5.1.2 comes from observations of growing or ongoing participation by individuals and groups in interactions focused on science practices, objects, ideas, or symbols. As a socially situated activity, science learning takes place in specific contexts (e.g., school classrooms, outdoors, teacher education classes), at particular times, with the possible inclusion of specific artifacts, and within particular physical environments (school buildings, universities, museums, outdoors, laboratories). All of these elements are important in shaping learning experiences. Before expanding this initial synopsis through detailed elaboration of selected studies, I present an explanation of IRT next.

5.1.1 Interaction Ritual Theory

Interaction rituals are focused encounters during which people are initially involved in a collective action or event (Collins 2004). During this involvement, some transient emotional stimulus forms an initial ingredient for directing attention to the actions or event. As individuals find themselves under these conditions, they are

primed for four ritual ingredients including the formation of a group through bodily copresence, some sort of delineation between who is a member of the group and who is not, a common focus for visual and cognitive attention, and a common mood among the group. Through a feedback system, the common mood and mutual focus of attention intensify one another. As such, an individual becomes more focused on the action or event as he or she develops a common mood with others. Greater focus of attention in the group parallels higher levels of attunement to the sentiments of others, and further intensification of a common mood. Eventually a heightened level of emotional arousal within the group may be achieved, which is called *collective effervescence.* This state of elevated group emotion spills over into four possible ritual outcomes, which include a sense of membership to the group (i.e., solidarity), heightened emotional energy within individuals, some representations (e.g., symbols) of the social group, and feelings of morality in adhering to the group, it's practices, symbols, and ideas.

Throughout this chapter, I will use the terms *ritual* or *interaction ritual* interchangeably with the phrases *focused encounter* and *focused interaction.* In the sociological sense adopted here, a ritual involves a communion between participants of an encounter resulting in a set of common thoughts and feelings that bind people together in a group (Collins 2004). Because of this theoretical attention on the common emotional and cognitive awareness within a group of people during shared practices, and due to the need for people to come together to achieve a shared focus on an action or event, the unit of analysis proposed originally by Erving Goffman (1967) was the *encounter.* Collins also takes this up as the unit of analysis in his theory. Instead of considering the individual as a *being* with fixed properties that is able to move across social situations without changing, for Collins, the individual is reconstituted into something potentially different with each encounter he or she traverses. This is an important analytical focus particularly in education research when we consider, for example, that students can be seen by some researchers or teachers to be a particular *type* of student based on fixed traits (e.g., a *student with misconceptions*). An alternative view, through IRT, is to understand the individual as someone who is constructed as one who possesses a misconception *during* moment-to-moment exchanges unfolding in classroom encounters. In this case, a *misconception* is an attribute of the social practices that evolve over time during classroom interactions. The misconception exists between the student and the teacher or other students as a property of the interaction, not as a property of the individual student's mind. This opening discussion of IRT is elaborated further through a review of empirical studies in science education.

5.1.2 Empirical Studies of IRT in Science Education

In one study focusing on student interest and engagement in science, Stacy Olitsky (2007) explored the ways in which 8th grade students in one US classroom developed feelings of membership to the *science class group.* Drawing on IRT, Olitsky

(2007) conceptualized science learning as a process of growing participation in the practices and sentiments of a science class (i.e., the *group*). Membership to the group was characterized by the development of a common mood among interaction participants who shared a visual and cognitive focus directed at science ideas and materials (e.g., laboratory equipment, science demonstrations, science concepts).

In her study, elements of successful interaction rituals were observed when iconic sports personalities, popular movies, or television shows were incorporated into physics instruction. All of these elements were familiar to the students as symbols imbued with emotions in contexts separate to the science class, such as television shows or during football games. When these elements were introduced into a physics lesson, they became familiar symbols that were used to access unfamiliar physics practices and ideas. In doing so, students gained access to physics and formed common feelings about physics ideas and practices that generated sentiments of membership to the physics class. This was made possible by the transfer of emotion from one symbol (i.e., sports icon) to another (i.e., physics concepts), a process that Durkheim (1915/1964) calls *contagion* (see also Collins 2004).

In contrast, when canonical science concepts were used solely for instruction in Olitsky's study, there was less mutual noisemaking in the class in the form of laughter, there were lower levels of synchrony in body movements, there was less attention focused on the physics ideas, and fewer students contributed to class discussions. All of these interactional phenomena provided evidence that the rituals had failed to produce a common emotional experience as predicted by IRT (Collins 2004). On a different occasion, however, when the instruction was focused on students solving chemical equation problems, entrainment through shared noisemaking—that is, collective emotion—was achieved. As students attempted the problems on the board, others shouted suggestions to assist them in solving the problem. The class became united in their efforts to assist the student working at the board. Although the chemical equations and the balancing equation problems consisted of symbols and practices that were not experienced typically by these students outside of school, they became resources for establishing a common cognitive, visual, and emotional focus. An important outcome was that the feelings of entrainment and emotional energy during the balancing equations practices were repeated over time indicating that membership in the science class group and engagement with the topic was sustained. This episode of classroom interactions illustrated that successful interaction rituals can develop without the inclusion of other symbols (e.g., sports stars) with which students are familiar in nonscience contexts. What we can understand from this balancing equations episode is that learning science involves the attachment of group emotion to scientific symbols (i.e., formulae of chemical elements/compounds). The attachment of emotion to science symbols is mediated through coordinated group practices such as answering a science problem.

An important distinction was evident in the balancing equations episode when compared to other classroom instruction involving the initiate-respond-evaluate structure of interactions. In an initiate-respond-evaluate episode during the physics topic, one student who possessed the right kind of cultural capital (e.g., used scientific terminology correctly) gained higher status in the group by answering

teacher-initiated questions correctly. Olitsky observed this during a physics lesson in which the teacher had greater confidence with the concepts than she did when compared to the earlier balancing equations example. Due to her confidence with physics, the teacher tended to ask known-answer questions relegating the students' role during interactions to one of providing correct or incorrect responses. This practice maintained the typical classroom power structure where teachers have the higher status, and higher emotional energy, than students due to possession of physics concepts (i.e., valued symbols in science class). Students who can answer questions correctly gain higher status and higher emotional energy for future interactions over other students when the teacher confirms their correct answers to questions. In contrast, the classroom interactions were dialogic during the balancing equations episode as students and the teacher contributed ideas collectively. This meant that students developed enhanced feelings of participation in the equation lesson as no single student held privileged knowledge, and neither did the teacher.

What the equation lesson illustrates is that it is possible for students to form feelings of group membership during science practices without the need for other discourses (e.g., football) with which they may be more familiar and with which they had previously formed emotional connections in other contexts. As shown through these examples from Olitsky's study, IRT provides a theoretical perspective for investigating the connections between collective emotions, shared symbols, and practices in the forms of physics and chemistry concepts and practices such as balancing equations. In doing so, the theory can inform research that seeks to explore the interrelationships between emotion, cognition, and embodied practices.

More direct exploration of the interplay between emotions and learning science concepts has also been achieved in science education research. Catherine Milne and Tracy Otieno (2007) adopted IRT in a study of high school chemistry involving science demonstrations. In the context of IRT, science demonstrations and the predict-observe-explain technique are social practices that pertain to the broader scientific practice of inquiry. Science demonstrations became the center of visual and cognitive focus for a group of high school chemistry students in Milne and Otieno's (2007) study. As the teacher repeated demonstrations overtime, there was an observed increase in student engagement through willing participation in responding to questions. When interaction rituals like these are repeated and they call up similar sentiments in a group over different occasions, an *interaction ritual chain* is formed (Collins 2004). Students who, in previous lessons, did not engage with chemistry symbols (i.e., language and concepts) began to adopt and apply them in an effort to explain observations during the demonstrations in Otieno's class. As predicted by IRT, individuals who did not typically participate in class discussions or did not respond to teacher questions became entrained during the demonstrations and gained the confidence to offer responses to teacher questions. Examples like this illustrate that individuals gain emotional energy overtime by participating in science demonstration rituals. In this case, emotional energy was evident from the student's confidence—a form of emotional energy (Collins 2004)—to take social action by proposing a prediction for the potential outcomes of the demonstration.

Students in Milne and Otieno's study transitioned from descriptions of observed phenomena during the demonstration to using chemical symbolic representations of submicroscopic processes in the demonstration lessons. Evidence of learning came from the students' willingness to adopt symbolic representations for explaining chemical processes after the demonstrations. From an IRT perspective, chemical symbols are valued objects that come to represent the *chemistry class group* and the group's practices. Adopting these symbols is a sign that students are willing to be identified as part of this group and that they have attached emotional energy to the symbols in the shared practices of science demonstrations earlier in the ritual chain. If the chemical symbols and language were not valued by students as representations of their science practices and membership to the chemistry class group, they would not be inclined to use them. The sense of solidarity derived from being part of the chemistry class group was established initially during the first science demonstration ritual. Willing use of these symbols by students is further evidence that emotional energy had built up during the science demonstration practices and carried over to subsequent interactions as part of the ritual chains that had formed in this class.

In a study of preservice science teachers, Alberto Bellocchi, Stephen Ritchie, Kenneth Tobin, Donna King, Maryam Sandhu, and Senka Henderson (2014) found that science demonstrations also fostered emotional engagement and group membership in a preservice science teacher education class. When the teacher, Donna, invited preservice teachers to predict the outcomes of a demonstration or to suggest possible explanations for observed phenomena, the students responded in similar ways as the high school science students in Milne and Otieno's study (2007). That is, there was evidence of emotional entrainment through synchronous vocalizations and body movements, and students contributed collectively to developing explanations for observed phenomena. During this time, students were learning about the use of science demonstrations as engaging approaches for teaching science in high school subjects. An interesting outcome of that study was that lower-intensity teaching episodes were considered by preservice teachers to be high-quality learning experiences as well as the higher-energy demonstration episodes. Lower-energy classroom episodes consisted of the teacher reflecting on her own teaching practice during the course of a lesson. When preservice teachers witnessed these reflections, they found them useful for informing their own practices. They also reported feelings of empowerment, which is a form of confidence in taking social action and indicative of growing stocks of emotional energy.

5.1.3 Summary of Part 1

In Part 1 of the chapter, I have discussed three empirical studies to illustrate applications of IRT in science education research. My intent was to show how learning science and learning to be a science teacher can be understood through IRT and to demonstrate the scope of this theory for exploring emotion and cognition as

interrelated phenomena. Applications of IRT in science education research have sometimes required the introduction of learning theories to commensurate this sociological theory of interaction with studies of science learning. For example, Olitsky focused on learning as legitimate peripheral participation in a community of practice and then accounted for the micro-processes in classroom interactions through IRT. Milne and Otieno focused on constructs of engagement that include behavioral engagement, cognitive engagement, and emotional engagement to understand chemistry learning. IRT was used to explore the emotional dimension of this engagement at the micro-interactional level and provided an overarching theoretical anchor for data analysis. My own work (Bellocchi et al. 2014) has also traced these lines without explicating theories of engagement or situated and embodied learning. For example, we accepted that *learning to be science teachers* was taking place in our preservice science class and focused our analytic efforts on understanding learning experiences from the perspectives of IRT. In many respects, these studies have provided foundational work related to applications of sociology of emotions and IRT in science education that can pave the way for something else.

That *something else* is the possibility of a more direct exploration of emotion and cognition during situated classroom practices. I present next a discussion of the origins of IRT in Emilé Durkheim's study of religious ideas to illustrate how a closer connection with his work can bring the study of emotion and cognition in more direct grasp of science education researchers and help to bridge the perceived disconnection between knowing and feeling highlighted by some education researchers (cf. Alsop and Watts 2003).

5.2 Part 2: What Else Can We Learn About Science Learning Through IRT?

In the studies discussed in Part 1, learning was evident during the use of science practices and symbols by students and preservice teachers or by preservice teachers adopting ideas about science teaching. It is important to note that Collins' development of IRT did not focus on *learning*, but instead on understanding social processes and macrosocial structures from the perspective of localized microsocial interactions. A key aspect of his work was to consider emotional energy as the initial ingredient for sustaining the success of social interactions, practices, and valued symbols in social groups. I propose that one way of extending the theory further into studies of learning is through greater integration of Durkheim's social epistemology of knowledge.

Collins (2004) developed IRT by drawing heavily on Durkheim's (1915/1964) germinal work *The Elementary Forms of the Religious Life.* Durkheim's study initiated interest in ritual theory, the sociology of knowledge, and the sociology of religion. Goffman (1967) subsequently provided a means for applying Durkheim's analysis of religious rituals to develop understandings of everyday encounters.

By treating any encounter as a ritual encounter, Goffman investigated all aspects of social interaction, from the mundane greeting in the street to formal occasions such as political speeches and teaching, as ritual practices. Like Collins, however, Goffman was not interested in understanding learning or the construction of knowledge in the scholastic sense. His focus was to understand what micro-interactional processes form the basis for social life and practices. For this reason, I suggest that science educators and other educational scholars interested in developing holistic understandings of learning and knowledge construction will find value in Durkheim's original study when considered in conjunction with subsequent developments by Goffman and Collins.

5.2.1 A Social Epistemology of Religious Ideas

Durkheim's study was focused predominantly on totemic rituals and beliefs among Australian Indigenous people, although he also drew on examples from a wide range of other indigenous groups to frame his arguments. The choice to focus on indigenous practices and beliefs was premised on the assumption that ritual practices associated with totemism represented the basic features of all other religious practices present in his time. That is, by studying the totemic beliefs and practices of Australian Indigenous people, he believed he could study the origins of practices and beliefs in the most basic religion that still existed. His analyses were focused on uncovering the social processes that lead a group of people to believe in the existence of a sacred force. Focusing on the idea of sacred force was important because it is essential to any religious system of beliefs or practices. More generally, Durkheim wanted to establish how any idea develops, not in the minds of individuals or experientially through the senses, but through social practices. He used religious practice and ideas as the basis for achieving these aims. Due to this focus, Durkheim's social epistemology of knowledge provided the link between practices, thoughts, and feelings that can offer a strong epistemological foundation for studies seeking to connect social practices, emotion, and learning/cognition in education research.

In the original text, *The Elementary Forms of the Religious Life*, Durkheim (1915/1964) devotes initial attention to elaborating the social basis of various aspects of human intellect (e.g., time, class, causality) through detailed analysis of ritual practices. Once he completes this analysis, Durkheim then presents an argument for the origin of the idea of sacredness that is derived from social practices. This was an unfortunate sequence in his work because the outcome of his study was that collective emotion experienced during social practices generates within the individual a feeling of moral force. This moral force then becomes the idea of sacred force that is attributed to sacred things (e.g., totems, symbols) existing outside of the individual. Categories within human intellect are formed subsequently due to the differentiation between sacred and profane things. For example, as I will discuss further in Sect. 5.2.3, the idea of time is borne out of the temporal separation

between sacred rituals and profane activities (i.e., nonreligious aspects of life). The sequence of Durkheim's text can make his overall argument about the social epistemology of knowledge seem obscure as Anne Rawls (2009) has noted previously. To avoid this challenge, I have sequenced my discussion of his work by beginning with the origin of the idea of sacredness before presenting examples of Durkheim's social explanation for the origin of human intellect.

5.2.2 Establishing a Social Epistemology of Knowledge

Durkheim outlined his intention of establishing a social epistemology of knowledge as follows:

> But our study is not of interest merely for the science of religion…For a long time it has been known that *the system of representations with which men [sic] have pictured to themselves the world and themselves* were of religious origins…But it has less frequently been noticed that religion has not confined itself to enriching the human intellect…*it has contributed to the forming of the intellect itself*. Men [*sic*] owe to it not only a good part of the substance of their knowledge, *but also the form in which this knowledge has been elaborated*. (Durkheim 1915/1964, p. 9, emphasis added)

In his analysis, Durkheim distilled all religions into a system of practices that sustain the idea or belief of *sacredness*. Sacred things are set apart from *profane* things and from those things that are forbidden. Those who adhere to these practices and beliefs constitute a *church*, that is, a union of people who represent a single moral community. In the first italicized section of the above quote, Durkheim refers to our system of representation, or cosmology, which is to say the ideas we form about natural phenomena and ourselves. His dual goal of establishing sociology of religion and a social epistemology of knowledge were interrelated. Part of Durkheim's argument for this dual focus was premised on the view that religions provided societies with their first cosmologies. Because religious practices and beliefs are social affairs, he then sought to demonstrate that human intellect itself (i.e., forms of knowledge and representation) also has a social origin. By studying religious practices, he wanted to understand the foundations of all cosmologies, and through this, as the second italicized section indicates, he believed his study would lead to understandings about the social development of human intellect.

In the last italicized statement presented in the quote, Durkheim refers to the way in which knowledge or the intellect is formed. In particular, he was interested in uncovering the roots of what Aristotle called *categories of the understanding*. These included, totality, cause, time, space, personality, and class, which were thought to form the foundations for all aspects of human thought. Durkheim's justification for studying these categories was presented as follows:

> Logical thought is made up of concepts. Seeking how society can have played a role in the genesis of logical thought thus reduces itself to seeking how it can have taken part in the formation of concepts. (p. 432)

He reasoned that the same processes leading to religious thought must have also shaped human intellect, and therefore the categories of understanding. The rationale for this was that religious practices and beliefs provided societies with their first cosmologies. During and before his time, the two dominant ways of dealing with questions of the categories of understanding were the *rationalist* (or *a priori*) method of assuming that knowledge is the product of an individual's rationality. In this view, we are born with fundamental categories as part of our natural mental constitution. We then impose the categories on our sensory experiences of natural phenomena. The other dominant view of the categories was that the individual was the craftsman who assembled his or her knowledge from different pieces of experiential information (an empiricist view).

The problem that Durkheim identified with the rationalist arguments was that they did not offer an explanation about *how* the individual developed the categories in the first place. Simply stating that they were part of our mental constitution did not address the question of how this came to be. The rationalists did not explain where the categories came from, accepting instead that they existed in the mind and were imposed upon objects and experiences by the individual's mind. In contrast, his issue with empiricist arguments was that sensory experiences of objects were not enough to provide an individual with *ideas* about abstract concepts such as causality. For example, observing that one thing preceded another would only add more information about each object. To develop the fundamental category of causality was not possible through sense experience. The idea of causality had to come from somewhere else other than the objects that were being experienced.

In contrast to the rationalist and empiricist perspectives and in order to identify the social origin of the categories of the understanding, Durkheim sought first to explain how social (religious) practices gave rise to the categories. To establish that the categories had a social origin based on practices was not enough. He also needed to demonstrate how it was that *religious* ideas came to *be* in the first place. Another way of stating this is that he needed to establish how the ideas of sacredness and profanity were developed and sustained through social practices, as these were the two fundamental categories of religious thought.

Departing from the arguments of both the rationalists and empiricists, Durkheim proposed that the fundamental categories of understanding originated neither from the individual mind nor from sensory experience alone but were foremost the collective representations of society and the mental state of the group that arose as a result of social practices. By placing the origin of categories in the social realm, he opened the possibility for explaining how an individual could come to accept an idea for which there was no direct empirical basis. For example, the idea of *classes* of objects or animals could not be based on any inherent property of the things themselves. Observing that one animal had similar features to another one did not imply the idea of class, and Durkheim did not accept that the idea of class was innate to the mind. So his focus was to establish how human societies came to the very idea of *class* through social practices given that *class* is neither an inherent property of the objects being classified nor one that is innate. Based on Durkheim's argument, the idea of class had to have a social origin. To explain the categories of

understanding such as class and causality, Durkheim first had to identify the social origins of the most fundamental religious idea of sacred force.

5.2.3 Feelings and Ideas of Sacred Forces

Durkheim found that all things considered sacred were endowed with a sacred force. The type of question he asked was, "Given that the objects and symbols representing sacred things do not possess an inherent sacred force, from where did societies develop such an idea?" His answer was that the only forces that could be experienced directly by members of a society were the group sentiments during collective practices such as religious rites or rituals (cf. the focused encounters in Goffman and Collins). In his work, *society* is understood to mean a group of people who engage in shared practices and beliefs (cf. Rawls 2009). During rituals, feelings were intensified because the group was gathered and focused on a single object and idea (a communion or sharing of intimate thoughts and feelings), and their actions became attuned to those of others through the rhythmic coordination of bodily motions and vocalizations. Individuals eventually lost their sense of self and experienced the collective effervescence (i.e., emotion) of the group as discussed previously in relation to Collins' conceptualization of IRT. Individuals became aware of the group/society as this feeling of heightened emotional energy, which originated from collective emotional experience during group practices.

It was through heightened emotional experiences that collective sentiments of the group generated within an individual a sensation of being transported outside of himself or herself. At this time, group sentiments directed at an object (e.g., a totem) were attributed *to* the object itself in a process described as *contagion* by Durkheim. Symbols that came to represent the groups' practices became imbued with group sentiments. In future situations, the symbols and objects themselves invoked the same feelings of emotion and respect within individuals that were produced in the group's first ritual encounter. It is through these collective sentiments that Durkheim found the sacred force of society that imbued with sacredness all manner of things including practices, objects, ideas, symbols, animals, plants, and group members. The *idea* that there was a force in those objects came from an individual's experience of the collective emotion during effervescent rituals that he or she then projected onto practices, objects, and ideas. The efficacy of the sacred force for causing all manner of observable phenomena, both natural and psychological, was not something mystical. It was none other than the collective sentiment of moral respect for group practices, symbols, and beliefs that was experienced by individuals as a moral force initially during ritual practices. Individuals later experienced this force as the drive to sustain the moral order of the group even when sacred rituals were not enacted. For the force to remain salient both to individuals and the social group, rituals had to be repeated. If this was not the case, the sentiments would dissipate over time during profane life and lose their efficacy as scared forces.

Once the experience of collective emotion was no longer considered by an individual to belong to his or her consciousness, the path was laid for the mind to accept abstraction. As Durkheim argued, in order to arrive at the idea that everyday phenomena have underlying patterns, the mind first had to become free from the limits of the senses. Sense experience, in and of itself, could not provide explanatory concepts like *forces* as causal agents of experiential phenomena, nor the *relationships* that were thought to exist between two or more observable phenomena. Individual minds first required the intellectual faculty for establishing causality and relationships before these processes could be attributed to objects. The fundamental categories of understanding were present in social life and it was social (or ritual) practices that provided the substrate for individuals to lay these ideas on top of sensory experience. In other words, it was not that the rationalists were wrong in thinking the fundamental categories preceded sense experience according to Durkheim. The issue was that rationality could not be explained in scientific terms (i.e., empirically), and thus the question of how it came to be that individual minds were capable of rationality could not be accounted for by the rationalist argument that this was an innate ability. By identifying the origin of fundamental categories first in social life and then by identifying the energizing mechanism by which these categories gained their salience for groups, Durkheim developed a social origin of the categories and an explanation for the way in which they are borne out of social practices before they become ideas in the minds of individuals. Because social practices are real phenomena, they are available for empirical study. In this way, Durkheim established a social epistemology of knowledge that could serve as the foundation for empirical studies in sociology.

5.2.4 Social Practices as the Origins of Categories of the Understanding

Having outlined Durkheim's social epistemology for the fundamental religious idea of sacred force, it is now possible to consider how he used this foundational explanation to account for the categories of understanding. Durkheim exemplified how the fundamental categories were first present in social life before becoming a part of individual thought. For example, *time* emerged from the temporal distribution of different types of sacred ritual practices to honor sacred objects (e.g., totems). The concept of *space* was derived from the geographical location at which different rituals were performed as distinct from locations where profane life took place. Classification was made possible by the existing social separation between individuals within tribes, clans, and subgroups within clans each represented by a different totem (i.e., a sacred object). Furthermore, the representation of each of these social divisions (e.g., clans) with sacred symbols (e.g., totems) created another system of classification that divided all things that were the same as one another (i.e.,

belonging to the same totem) from those belonging to a different group (i.e., a different totem). This also paved the way for notions of *similarity* and *difference.*

5.3 Part 3: Science Learning as Durkheimian Ritual Practices

I have presented a discussion of Durkheim's social epistemology in the preceding sections to illustrate foundational ideas that hold the most value for extending Collins' IRT into a sociology of learning. I now take up these ideas in Part 3 to suggest how they might be applied in science education or general educational research.

There is a limitation to Durkheim's study that he could not eliminate in order to achieve his ultimate goal of understanding the origins of religious ideas (and categories of understanding). If we take one step back in his reasoning, the choice to focus on totemic practices of indigenous cultures was based on the assumption that these practices were fundamental to all modern religions and that the groups he studied had the simplest social structures known and still practiced in Durkheim's day. By studying indigenous religious practices, he reasoned that he was studying the same thing as modern religion but in a less complicated form. In doing so, he thought he could access the essence by which religious ideas are formed and thereby establish the social origins of the categories of understanding.

What he could not do, however, was to study the beginnings of a *new* religion, which would have been the definitive way of answering his questions about the origins of religious ideas and sacred forces in ritual practices. This did not go unacknowledged as Durkheim noted that there was no such thing as the *first* religion. It is also unlikely that historically older rituals were devoid of the ingredients that were identified in the societies that he studied. An issue implicit to the approach he took to his study, however, was that once ideas became represented as collective practices or symbols, they were then subject to being modified from their original forms through social construction. This is partly the reason why Durkheim argued for the study of practices rather than symbols (i.e., social constructs), as symbols can lose their connections to empirical reality as they are socially manipulated over time. Such was his rationale for not studying modern religions that Durkheim saw as involving too many practices and beliefs that were not foundational to establishing or sustaining the idea of sacredness. Yet the indigenous groups that were his focus had well-established practices and thereby numerous socially constructed ideas to go with them. This did lead to a focus in his analyses on less complicated practices than those of modern religions, but certainly did not provide the foundational perspectives he was seeking to achieve.

The implication of this limitation for conducting research in educational contexts, following Durkheim's epistemology, is the need to focus on the one element that preceded all others with regard to fundamental categories and ideas of sacredness, that is, *society*. But society, in the macro sense of the term, is likely to have

been a construct too large for achieving the focus of attention required for practices and ideas to be shared quickly and for those ideas to gain salience for a group or for individuals. It is likely that before practices could become established into what may be recognized formally as a *religion* or as *totemism*, smaller groups began to share practices and ideas. I posit that these smaller group practices were the likely starting points for what later became more widely shared religious (or any other) practices. Studying the formation of ideas though localized social practices in small groups may move us one step closer to Durkheim's goal of understanding the *foundation* of human intellect. Although his argument focused strongly on empirical evidence from social practice, in order for a practice to be considered *social*, it had to belong to a society, that is, to a social group. That which keeps smaller societal groups together is the social bond between individuals (Scheff 1997; Turner 2007) and solidarity within larger groups (Collins 2004). To study the origins of human intellect, it follows that one should begin with the study of social bonds that make, break, and sustain a social group during social practices.

5.3.1 Social Bonds and Social Solidarity

Social and emotional ties constitute social bonds and they are important because larger societal groups cannot exist without them. Social bonds also form the foundation for the formation of social solidarity within larger groups (cf. Scheff 1997). In Durkheim's (1915/1964) formulation, the sacred force experienced by ritual participants is none other than the moral pressure they feel within themselves due to their social bonds to others and due to the solidarity they feel toward the larger group during situated social practices. Without this social and emotional connection, a moral sentiment cannot arise because it has a social origin not an individual one (Durkheim 1915/1964). Most importantly, social bonds and social life are mutually constitutive so that one cannot precede the other. There is no root cause as it were, in this context, other than the coherent social group (i.e., the society) that has formed by establishing emotional and social connections overtime during common practices. In feeling a social bond to others and in feeling solidarity with larger societal groups, individuals feel the moral force that Durkheim described in relation to religious groups. Moral force is derived from social emotions and it is this aspect of social bonds that is central to the formation of a *cohesive* group. Although any collective of individuals can gather together and engage in similar practices, such a gathering does not necessarily imply that a moral order has been established as a result of the formation of social bonds. It is important then to understand the extent to which ideas depend upon the cohesion in groups engaged in shared social practices.

I propose that one way of studying the origins of an idea or concept is by attending to the formation, maintenance, and disruption of social bonds and solidarity within groups of different sizes. Bonds involve dynamic social processes that fluctuate over time; they involve ritual ingredients including common emotions and common visual and cognitive foci that are salient during social encounters (Scheff

1997; Turner 2007). I predict that changes in patterns of social bonds during a learning experience/practice will coincide with changes to group morphology, practices, and changes in emotional energy being directed at different ideas. As such, the salience of different concepts for different groups and individuals within those groups is expected to arise from changes in social bonds, morphology, and emotional energy. When individual students, for example, begin to form social and emotional connections to the teacher, to other students, or groups of students (including those with whom they do not associate typically), it is expected that these transient individuals will begin to form new ideas as they engage in different or new social practices.

There is an important difference to note here between the rituals we are likely to observe in everyday educational contexts and those at the center of Durkheim's study. The religious rituals performed by indigenous people were described as highly effervescent. Undoubtedly these highly emotionally charged times gave rise to collective ideas and influenced the minds of individuals. But much of social life unfolds in less dramatic ways, and it was this mundane reality that Goffman recognized when he applied ritual analysis to everyday undramatic encounters. By focusing on the rituals that sustain everyday life, it became possible to extend Durkheim's analysis beyond the investigation of religion or fundamental categories at highly effervescent times. However, neither Goffman nor Collins took up the study of mundane rituals to understand the formation of concepts in the scholastic sense. It is precisely here that I see scope for education researchers to make a contribution. As education researchers we are in a position to capture moments of practice when students are forming initial ideas through formation, maintenance, and disruption of social bonds. Only then are we in a position to address Durkheim's original goal of exploring the *origins* of ideas and knowledge. This does not imply just those ideas that constitute fundamental categories; *any* idea in any context could be understood by the methods that Collins, Goffman, and Durkheim used to understand their subject matter through inquiries founded on Durkheim's social epistemology of knowledge. One way to achieve this goal is through a microsociological focus on learning experiences/practices.

5.4 Toward a Microsociology of *Learning* (Science)

We are now in a position to consider what a *microsociology of learning* could look like through integration of Durkheim's social epistemology of knowledge with the modern theory of interaction rituals developed by Collins and its contemporary applications in science education research (e.g., Milne and Otieno 2007). I propose first that a shift in terminology from use of *knowledge* to use of *learning* is necessary. This is an important shift for a dynamic microsociological focus to take hold because *knowledge* can suggest some fixed object, which is complete and enduring. What I am interested in is something more fluid that enables ideas to change as interactions, practices, and social bonds change on a moment-by-moment basis.

The idea of process implied by *learning* captures this more effectively than focusing on knowledge. An essential elaboration to IRT that we can make from Durkheim's epistemology is that ideas or concepts originate from social practices and morphology and that social emotions are central to the way ideas are formed first in the group and how they subsequently take hold in the minds of individuals. As groups and their practices change, common ideas will change accordingly. Focusing on fluctuations in social bonds and social solidarity provides an empirical basis for establishing whether or not a cohesive social group has formed and whether or not a moral order has developed within that collective. Depending on the development or lack of development of a moral order, we can then proceed by studying the significance of social practices in the development of group and individual ideas.

If we accept that learning is a process involving formation or changes in practices, ideas, social bonds, or sentiments, then we can also add that it is constituted through growing participation in group activities focused on any or all of these elements (i.e., feelings, ideas, and practices) of an interaction ritual *when a moral order is being or has been established*. Moral order is evident when a high level of respect is afforded to practices, ideas, objects, and symbols. Formation of an idea then is shaped by these elements and becomes represented in objects, symbols, symbolic actions, and bodily movements or sounds. It is only when students are engaged deeply in science practices that the ideas they are forming will become apparent. I use the term *science* here to refer to scientific practices and concepts collectively. It is essential then to start with the investigation of those learning experiences that most closely resemble the practice of scientists if we are interested to learn about the development of scientific concepts in students. Most commonly in school settings, this occurs when students are engaged in extended scientific research projects (i.e., inquiry projects). What is important in analyzing interactions in such practices is to identify when groups are gathered; whether or not social bonds are formed, maintained, or disrupted; what the group is doing; and around what initial concepts or proto-ideas the collective attention is focused. These ideas may or may not be the concepts valued in the formal/intended curriculum because ritual analysis and microsociology of learning is about active and evolving social processes.

5.4.1 Lived/Enacted Curriculum

Microsociology of learning may be best understood in traditional educational terms as the study of enacted or lived curricula rather than being conceived as studies of the intended curriculum, although the two are not mutually exclusive. It may in fact be best to bracket initially the formal or intended curriculum so that it does not get in the way of seeking to understand the processes by which student groups form social bonds, practices, and ideas in the context of science (or any other school subject). Moreover, the lived or enacted curriculum may not align with the intended one at all, but we can investigate the interplay between practices and ideas that develop

during classroom interactions in relation to the intended curriculum post hoc if this is considered to be a desirable line of inquiry. The most salient aspect to determine through a microsociology of learning is what binds individuals or groups together in a science class and how experiences of collective practices and emotion are achieved. Once this has been achieved, we can then isolate and trace ideas that are charged up by group sentiments over time. In this way, we begin by studying the practices and ideas (i.e., science concepts or concepts about science) of student groups rather than imposing existing ones from a curriculum onto the group.

A dynamic microsociology of learning becomes possible when a group is studied for an extensive period of time (e.g., through prolonged video ethnography) such that the fluctuations of collective emotional energy and individual emotional energies can be observed and so too can changes in social bonds and solidarity be tracked over time across a range of social practices. These fluctuations may be representative of emotional change (Bellocchi and Ritchie 2015; Bellocchi et al. 2014), which in turn is indicative of the ideas that are coming to form a central focus (i.e., being learnt) of the group's attention.

I have argued elsewhere in the context of an intended curriculum that emotional change was indicative of the transformation of conceptual understanding about scientific energy concepts (Bellocchi and Ritchie 2015). A class of 8th grade science students was learning about energy in a Physics course through laboratory exercises involving different devices whose functioning could be understood in terms of energy changes. After these experiences, students were asked to share their responses to prearranged questions focused on the energy changes operating in the devices. One student offered an answer to a teacher question about the first device. His response was not consistent with the canonical science explanation (i.e., the intended curriculum) expected by his teacher. This led to a range of emotions for the student such as frustration and embarrassment when he was told his answer was incorrect. While he was focused on holding his ground that his answer was correct, the student did not show changes in his canonical understanding of the concept. As classroom discussion ensued with other students responding to new questions, he then realized the incongruity between his first response and what was expected. His emotions changed first to surprise and later in the lesson to pride and triumph when he answered correctly other questions involving the same energy change as the one related to the first question. That study provided evidence that emotional change (i.e., a shift from anger/irritation, to surprise, and then to pride and triumph) was associated with conceptual change in the students' understanding of energy concepts. Although the focus of the study was on the intended curriculum, the same methods could be applied to study enacted and lived curriculum. In the latter type of study, we could ask, "During what social practices did the student form his initial (i.e., non-canonical) ideas about energy?" and "Were social bonds formed, maintained or disrupted during those interactions?"

It is possible to adopt the same methods as those used in a range of other studies discussed in Part 1 (see also Ritchie et al. 2016), to focus on ideas that are emergent and contingent upon group interactions, social bonds, solidarity, and practices. At the center of such investigations lies the importance of the formation and disruption

of social bonds that are dependent on emotional and social ties formed among groups of students who gather to focus their visual, emotional, and cognitive attention on some common object (a science idea or practice). Observable fluctuations in social bonds are also a dynamic way of monitoring how ideas are formed within groups and sustained or not sustained by individuals in subsequent encounters.

5.4.2 *Future Directions for Microsociology of Learning in Science Education Research*

The microsociological view of learning presented in the preceding section, with the central focus on practices, social bonds, and emotional changes, offers a holistic view of learning where practices, emotion, social bonds, and cognition have equal footing in understanding learning. Although the ideas that are formed by groups are still directed at experiential phenomena, or an external reality (including ideas themselves as social realities), an understanding of this reality is constructed through an emotionally charged set of social practices. This emotional energy can be both of the more intense effervescent variety as seen in studies of dramatic emotions like pride and triumph (see Bellocchi and Ritchie 2015), or it can be focused on the more subdued but ever-present emotional energy that ebbs and flows in interactions (see Davis Chap. 7 this volume).

There are now a growing number of studies focusing on specific (high-intensity) emotions in science education (e.g., Bellocchi and Ritchie 2015). A different direction for this kind of work is possible with a subtle shift in focus on the way in which we conceptualize emotion and school science practices. The term emotion and specific emotion labels such as joy, happiness, anger, fear, and love can create the impression that there is a singular objective reality available for investigation. That is, we can assume to study *anger* or *love* as some real object that has fixity both spatially, temporally, socially, and culturally and as a concept. In a similar way, investigating science learning as a *social practice* or studying *the practice of science* may suggest a singularity in the idea of scientific practice. What I have come to understand from my own work on learning science focusing on emotion and social practices is that we can learn more if we shift our thinking about the aforementioned constructs by focusing on their adjectival or verb forms. Such investigations would focus on, for example, in the case of emotions, *loving* or *love* in the verb form or *anger* (in the verb form) in the present situation and how this leads or does not lead to a situated or enduring idea of *love* or *anger* (in the noun form) for the interaction participants. This idea can be extended more generally to the study of *emot-ing*[1]

[1] I am not using the term *emoting* based on the English dictionary derivation of *emote*. In contemporary usage, emote means to act out an emotion, for example, in the context of theater. At the same time, I am not excluding this performative perspective from my overall argument. I have simply chosen to avoid the performative aspect in the present discussion. I acknowledge that emotional/affective performativity is yet another important aspect in the study of emoting and affecting in education research that should not be dismissed or excluded from empirical investigation.

rather than emotions or *affect-ing* rather than affect. In the context of scientific social practices, the focus becomes the study of *practicing science* rather than a singular scientific practice. In this way, *scientific practices* and *ideas* are studied as emergent and contingent realities within educational contexts.

A microsociology of learning asks questions such as "How are social and emotional bonds established, maintained, and broken during interactions focused on science practices?" "What (science) concepts/practices arise from *this* situation?" "Where is emotional intensity directed during the practice/interaction?" "Who is assembled when these social practices are generated or circulated?" "Who is excluded?" "In what way, if any, do the practices/ideas formed by those excluded from the group differ from those who form part of the group?" "How is a sense of time, place, or space developed around the practices and ideas of the group?" "Are the same practices and ideas circulated again in some other place or time?" "Who (re)assembles in these later interactions?" I think the first two questions are the most important ones initially with regard to pathways that connect emoting and learning/cognition in science education research. The moral or political authority of the scientific establishment and that of the curriculum authorities seeks to sustain, knowingly or otherwise, the primacy of formal curricula. But if students and teachers do not accept this formal curriculum, it's efficacy for sustaining the place of scientific practices and ideas at a high social status is lost. Similarly, efforts to engage disaffected students with school science through a preordained curriculum are not likely to have widespread success if the same practices and ideas championed through formal curriculum are not borne out in situated local practices that lead to lasting social bonds, for example, in school classrooms. Scientific practices need to be efficacious in addressing the needs of the smaller groups before they are likely to gain salience for larger social groups. Science needs to bind small groups through social bonds and large groups through solidarity if it is to hold a high status within student groups or society in the wider sense of the term. A microsociology of learning founded on social epistemology can deepen our understandings about these issues.

5.4.3 Concluding Remarks

My goal in this chapter was to articulate some of the basic assumptions and applications of IRT for science education research (Part 1) and to suggest new directions in which this research may head by connecting more closely with Durkheim's social epistemology of knowledge (Part 2). A microsociology of learning was proposed in Part 3 that is founded on Durkheim's social epistemology and IRT and foregrounds the role of social bonds and emotional change in learning. This chapter is an attempt to take contemporary IRT and supplement it further with aspects of Durkheim's work as well as more recent developments about social bonds (e.g., Scheff 1997), solidarity (Collins 2004), and empirical studies in science education that can move our thinking forward and perhaps engage a wider range of researchers with these

perspectives. The choice to discuss Durkheim's work and IRT in the context of developing holistic understandings of emotion and cognition can be received as establishing a dualism between mind and body. This choice in terminology was a difficult one to make because I did not want to convey such a view of learning (or being). My choice in the use of these terms has been purely to make the perspectives presented in this chapter accessible to a wide audience, including those who may come from lines of inquiry in science education different from my own. From a personal perspective, I accept that we are inherently emotional so that we may experience higher or lower levels of emotional energy, but not a complete absence of it that would make it absent during cognitive processes. I have commenced some of the microsociological work discussed in Part 3 in my own empirical studies of science classrooms and preservice teacher education. Beginning with a focus on the social epistemology of knowledge and extending into the study of social bonds, I seek to develop further a microsociology of learning as outlined initially in this chapter. This has so far been an exciting and fruitful journey.

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