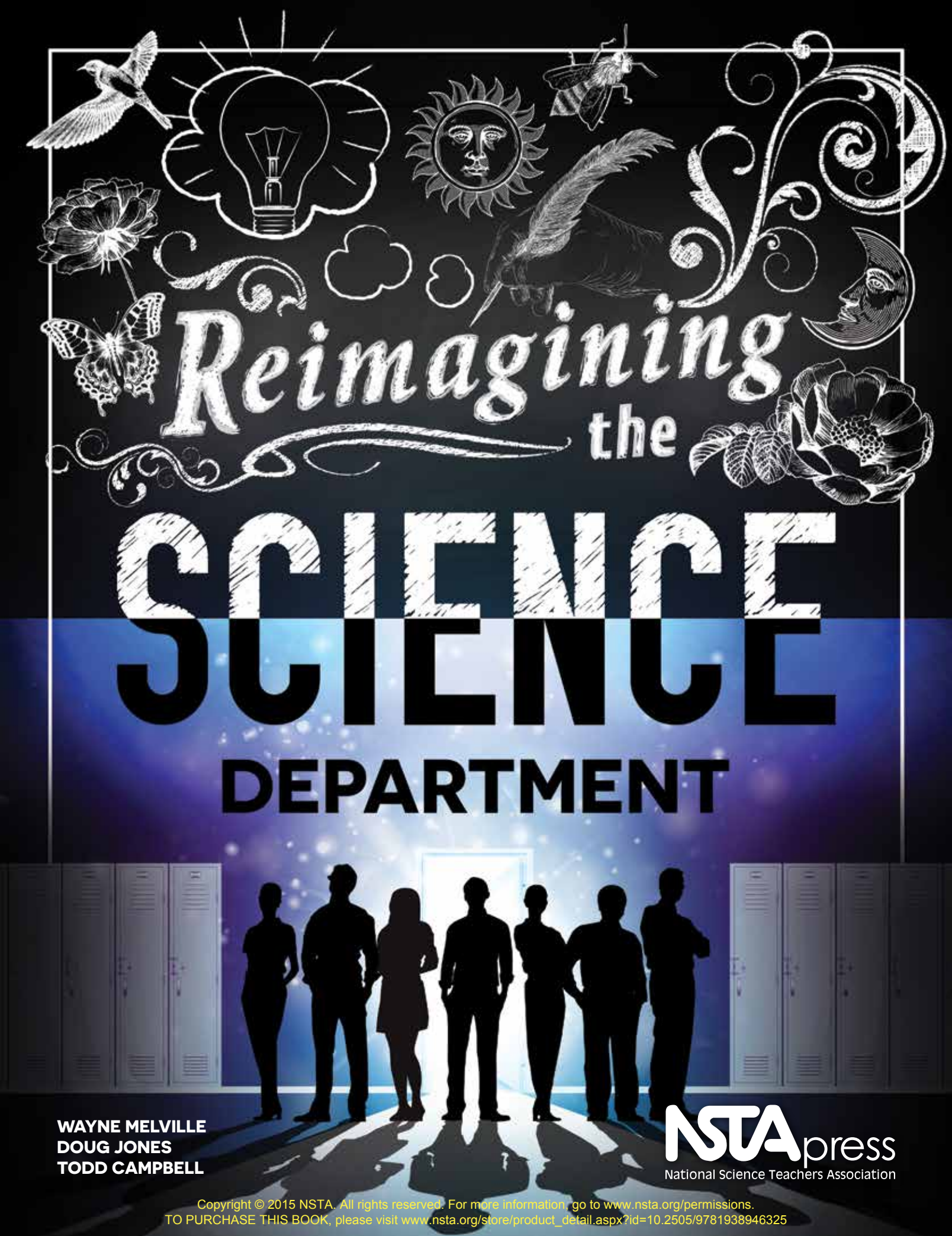

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Reimagining the SCIENCE DEPARTMENT

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FOREWORD

Why would anyone want to write a book about something as universal as the secondary science department? Science departments are a common feature in secondary schools, and everybody knows their purpose—right? Most typically seen as convenient administrative units within the school, science departments have also been described as the engine room of the school, the place where the hard work of teaching and learning science occurs. More ominously, for school administrators they can also appear completely impervious to the most carefully laid plans for school improvement and reform. Put simply, the ubiquity of science departments means that they are often hidden in plain sight.

Even within the research literature, serious investigations into departments are relatively recent phenomena. In her seminal 1994 work, Leslie Siskin defined four aspects of subject departments that she believed were crucial to understanding their importance: (1) Departments are administrative units formed along their strong disciplinary boundaries; (2) they are the primary places for teachers' social interaction; (3) they have considerable power over what and how teachers teach; and (4) they judge what is considered acceptable in terms of teaching and learning for the discipline (Siskin 1994). These aspects have guided our work with departments, as both chairs or researchers, over a number of years.

However, two things have become obvious to us in undertaking our work. The first is that the functions—and nuances—of departments are still not well understood in the research literature, and even that limited understanding has made only a slow passage into schools. The second is that the critical role of the chair remains an area that is both understudied and undervalued. This situation is concerning, particularly when it is known that chairs are the linchpin between the principles and assumptions supporting proactive reforms and their successful implementation. The United Kingdom's Teacher Training Agency (TTA) phrases it this way:

> *A subject leader has responsibility for securing high standards of teaching and learning in their subject as well as playing a major role in the development of school policy and practice. Throughout their work, a subject leader ensures that practices improve the quality of education provided, meet the needs and aspirations of all pupils, and raise standards of achievement in the school. (TTA 1998, p. 4)*

Science chairs are generally more experienced teachers with a solid grasp of both science content and pedagogy, and as middle managers they are in a unique position to influence the teaching and learning of both students and the teachers in their department. Yes, chairs have a responsibility to be good managers of the administrative side of the departments' operation. More importantly, they have the responsibility to be instructional leaders in their departments and to so help enact reforms to science education such as the *Next Generation Science Standards* (*NGSS*). However, if one looks at the history of reforms in science education, one sees a series of initiatives that looked good on paper but that stayed on the paper. Reformers often bemoan the inertia of teachers but continue to concentrate on the *what* of reform rather than the *how* of reform. The result is that increasingly cynical teachers see that the more change is called for, the more things stay the same. Clearly, such a situation does not benefit anyone, least of all the students in our classrooms. And make no mistake, students are voting with their feet and walking out of the discipline that we love. As Tytler (2007) points out, there is crisis in science education, characterized by secondary students developing increasingly negative attitudes toward science, a reduced participation in postcompulsory science education (especially in physics and chemistry), shortages of science-based workers, and a shortage of qualified science teachers.

This might all sound rather discouraging, but it also establishes the rationale for our work here. We firmly believe in the professionalism of science teachers, and as current, or past, chairs and science teachers, we understand and respect the pressures that act on both teachers and chairs. The purpose of this book is to assist science chairs, teachers, and administrators in beginning the task of reimagining the science department as a place where teachers are encouraged to question both their beliefs about science and the teaching and assessment strategies that develop in response to those beliefs. Only when teachers have the freedom and capacity to question their beliefs and develop their teaching and learning can real improvements in the teaching of the practices of science be sustained. This belief holds regardless of the school being urban, suburban, rural, public, or private. Between the three of us authors, we have taught in urban and rural independent schools in Australia, suburban public schools in Canada, and rural and urban Midwest schools—sometimes as the sole science teacher in the school. The writers of the vignettes, and our colleagues who have critiqued the earlier drafts, come from urban and rural areas in Ontario, New England, Georgia, and Texas. Different places and different teaching contexts, but for everyone who has contributed, the underlying departmental issues at the core of the work we are suggesting are the same.

The three-part structure of the book is designed to provide the reader with a firm foundation on which to base their actions. The first section, Chapters 1 and 2, places the science department in the context of its historical development, the relationship

between the department and traditional science teaching, and the important (although under-recognized) role of the department in teacher professional learning. Most of us hold closely to an academic tradition of science education, and we need to recognize this before we can challenge it and its continuing impact on our teaching. The second section, Chapter 3, draws on the leadership and professional learning literature to consider the roles and responsibilities of science chairs in becoming instructional leaders. This section elaborates on many of the remarks in the National Science Teachers Association's position statements on leadership and professional development. We need to know the difficulties we will face if we are to move from recognizing, to challenging, to reforming our teaching and learning. To be prepared to reform means giving teachers good reasons to change. The pressure for reforms is not going to stop, so we need to be clear about the forces that drive that pressure and be proactive in dealing with them. The third section, Chapters 4 and 5, provides advice backed by research and experience on how to initiate reforms within the department and work with administrators to sustain and grow those changes over time. In this section we look at how chairs can make a start developing the credibility that is needed to influence the perceptions that departments have toward reforms, before finishing with the need to develop strong trusting relationships with school administrators in support of the work of the chair.

In our writing, we have constantly sought to avoid creating an "academic" book in the negative sense of two covers, pretentious prose, and wall-to-wall references. Such an approach does not reflect the day-to-day reality of departmental life. Conversely, where scholarly references add weight to the argument that we are making, we thought it appropriate that they be included. Theory and practice should not be seen as being diametrically opposed, they should inform and direct each other to improve the quality of teaching and learning. Our students deserve nothing less.

In each chapter we have included vignettes written by our colleagues that highlight the particular points made in the text; the issues that are faced are universal, and it is always nice to know you are not alone. We have also included questions to ask of yourself as a science teacher and as a chair. Such questions are important because to challenge the assumptions that underpin one's teaching, and then begin to really shift one's teaching and learning to a position that more closely resembles the ideals in reform documents such as the *NGSS*, is an intensely personal journey. Please feel free to rephrase the questions and use them in your own department as you see fit. As part of that journey, we would also like to invite you to send us anecdotes of your own trials, tribulations, growth, and successes connected to any of the chapters. If there is any way in which we can help you in your work, please don't hesitate to contact us.

Regards,
Wayne Melville, Doug Jones, and Todd Campbell
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3

ROLES AND RESPONSIBILITIES

The science department has existed in its current form for approximately 100 years. Over that time, the department has reflected the changing nature of the relationship between society and science. As science has acquired for itself greater prestige and power, so too has the science department become more entrenched at (or near) the top of the subject hierarchy found in so many secondary schools. This position has been reinforced by the close connections between university science faculties and departments and between disciplinary science and the academic script of science teaching. There is a tradition among science teachers as to what "good" science teaching looks like, and given how heavily teachers are socialized into this tradition, it is extremely difficult for an individual to challenge it alone. If, however, we believe that departments are places in which science teachers can begin to understand and challenge why they teach the way they do, and the imperatives for change, then we must also understand the roles and responsibilities of the person charged with the administrative management and instructional leadership of the department: the chair.

In this chapter, we start by considering how the role and responsibilities of the chair have evolved over the past 170 years. Following this history lesson, we will move on to consider the work of Jeremy Peacock who, working from the literature on science chairs, has highlighted four important leadership capabilities for contemporary science chairs looking to enact instructional leadership practices in their department. Those capabilities are then brought together with leadership theory to explore the relationship between departmental and instructional leadership. Establishing the links is not the same as providing a checklist that says "do these things and all will be well." It is a guide for understanding the nuances of leadership within the department. The hard work, as always, is to put the guide to the test in the day-to-day life of the department. Next, we will ponder the implications of the dominant current department structures on the leadership of the chair, before moving on to consider

how chairs position themselves between the work of the department and the (often contradictory) requirements of districts and legislators. Finally, we will turn our attention to getting started on the road to reimagining the department.

The Chair: A Short History

The position of the chair has never been clearly defined, despite its key role in shaping instructional leadership within the department. The role has been seen at times as simply administrative: making sure that school policies are enacted and adhered to; at other times the chair has been tasked with ensuring that the examination requirements of the universities are met; and at still other times chairs have been given the responsibility for improving teaching and learning. Increasingly, however, all of these roles are being simultaneously delegated to the chair. One thing that has remained constant, however, is that the position has always been somewhat ambiguous, with little agreement on the functions or selection criteria. The more things change, the more they stay the same—since at least the 1840s.

Early Days: 1840s–1905

In the 1840s the early science educator Richard Dawes believed that the primary role of the teacher was to make "children observant and reflective; to make them think and reason about the objects about them … to instruct them in the school of surrounding nature, and to bring their minds to bear on the every-day work of life" (Layton 1973, p. 42). To achieve this, Dawes instructed the teachers in his parish schools in both content and how his curriculum was to be implemented. Dawes had little time for discussions into differentiated curriculum for different social classes. For him, teaching was a matter for which "the real difficulty of the question is not with the people, or the classes to be educated … but in getting it out of the hands of talking men and into those of the practical and working ones" (cited in Layton 1973, p. 48). The professionalization of science was to change this perception of the learning required by science teachers.

The establishment of science subjects that were closely aligned with the university disciplines had a profound effect on teaching and learning. For example, science (in the form of systematic botany) was established as a subject at the Rugby School in the 1850s and was taught as a "pure" science. Science was seen as a commonsense activity that required the learning of specific content and the laboratory skills needed to enter university science. As such, there was little effort to develop the pedagogical skill of the teachers. The role of the science chair was principally administrative, ensuring that the university-imposed standards were met. As we

have seen, Michael Faraday spoke against the manner in which science was being taught, arguing that the result of an abstract scientific education was that even the supposedly well-educated were, in science, "ignorant of their ignorance" (Public Schools Commission 1864, p. 381).

Establishing Departments: 1905–1950s

From Kilpatrick's usage of the term *department* in 1905 until the middle of the 20th century, two important forces acted to shift the role of the chair away from the administrative focus of the early period. First, in the United States there was a significant growth of secondary enrollments driven by a number of factors: major demographic changes with large increases in immigration, the increasing urbanization of the population, and major changes in child labor laws. According to Sheppard and Robbins (2007), there was "an approximate doubling of the high school population every 10 years from 1890 to 1930" (p. 201). This increase was matched by the loss of influence of the "mental training" view of education. Science teachers began to assert themselves as more than scientists: They were also educators. Writing specifically on biology, Sheppard and Robbins (2007) state that:

> *There was a rejection of the college dominance of the biological sciences as being abstract and impractical ... High school teachers wrote the new biology texts, and the biology syllabi were adapted to the developmental needs of students who would be in the earlier grades. The content of the course was more practical. (p. 201)*

For chairs in the early 20th century, this meant the evolution of an increasing responsibility for pedagogy, supervision, and administration. The situation, however, remained quite fluid as the trend toward teachers' disciplinary education produced departments staffed by specialists who reinforced the academic script of science education. Unsurprisingly, the first empirical studies into the role of the chair concluded that the position was in a state of confusion, with little agreement on either the chairs' function or the criteria for selecting chairs (Peacock 2014). Later researchers reported that that the sources of this confusion were not dealt with. Chairs were too busy with teaching and administrative trivia to focus on their main function of instructional supervision, and many chairs were not consulted on personnel issues affecting their team of teachers. In 1947, Lowry Axley compared the role of the chair to that of a racehorse burdened with the duties of a plow horse:

> *The departmental plan is based on specialization, but apparently very few systems make full use of the specialized training of heads of departments. The owner of a champion racehorse expects a championship*

> *performance when his horse is put to the test, and he would be considered a congenital idiot if he burdened his racer with the duties of a plow or draft horse in addition to his racing ... Their main function is lost sight of, and they are not given proper opportunities to use their training to promote the efficiency of their schools. (Axley 1947, p. 274)*

In the 1950s, research began to focus on the potential importance of the chair to improving the quality of instruction within the department. Rinker (1950) suggested that chairs should maintain a simultaneous focus on supporting students and teachers, while developing links to academic, professional, and school communities, while also performing clerical duties. This focus has continued to be developed over the past half century.

Latter Days: 1960s to the Present

In the 1960s, changes in research methodologies allowed researchers to investigate the chair's work and to analyze the relationships between the specific factors that affect that work. These methodologies developed even as the publication of Schwab's "The Teaching of Science as Enquiry" touched off an ongoing questioning about the meaningful purposes of science education. Given that the pressures for reform are only intensifying, the capacity to differentiate between aspects of the chair's work is an important step in understanding the role and the impact that it can have on teacher professional learning. While the earlier concerns about the role of the chair continue to be reiterated, there is an increasing awareness that "chairs are in an ideal position to facilitate instructional improvement because of their daily contact with teachers and their own instructional expertise" (Weller 2001, p. 74). This recognition is based on a number of factors. As science teachers are socialized into their departments, chairs are in a strong position to offer leadership around teaching and learning. Consequently, departments can represent an important site for professional learning and also function as a link between teachers and other science education organizations such as the National Science Teachers Association (NSTA), the National Science Education Leadership Association (NSELA), and university science education faculty. The NSTA position statement "Leadership in Science Education" outlines the roles that science leaders, including chairs, have in the implementation of reforms such as the *Next Generation Science Standards* (*NGSS*). Unfortunately, despite the growing awareness of the potential for chairs to provide leadership, they remain underused as a resource for improving instruction (Weller 2001). The overwhelming picture remains of chairs being asked to do too much with too little for too long—of racehorses continuing to be being burdened with the duties of the plow horse.

So, what does current research tell us about the leadership required of chairs in implementing reforms such as the *NGSS*? The recent work of Jeremy Peacock, a former science chair and a regional content specialist from Georgia, highlights four important leadership capabilities for contemporary science chairs who are seeking to provide instructional leadership in their departments.

Leadership Capabilities

Peacock worked through the research literature on the roles and responsibilities of the science chair from 1910 to 2013. This material has been analyzed using the concept of leadership capabilities that can be defined as the "seamless and dynamic integration of knowledge, skills, and personal qualities … [required for a] practical endeavor such as school leadership" (Robinson 2010, p. 3). From this work, four core leadership capabilities emerged as contributing to the ability of science chairs to offer science instructional leadership:

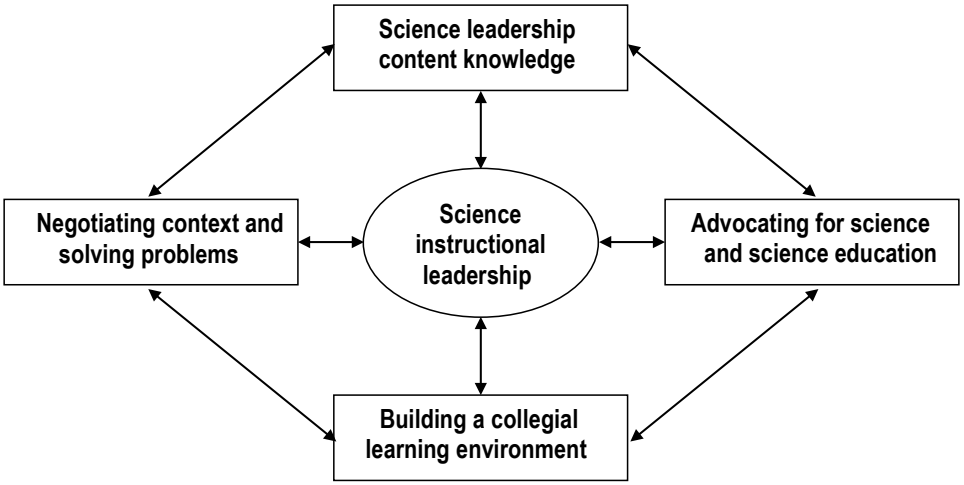
- Science leadership content knowledge
- Advocating for science and science education
- Building a collegial learning environment
- Negotiating context and solving problems

The relationship between leadership capabilities and instructional leadership is shown in Figure 3.1 (p. 52). Peacock makes the point that, while the leadership capabilities are interdependent and carry equal importance, the particular arrangement of the capabilities is intentional. Given that the role of subject-specific leadership is generally underrepresented in the literature, science leadership content knowledge is given prominence at the top of the figure.

The value of Peacock's work is that it draws from the literature to provide a guide to the capabilities that chairs need to work with if they are to reimagine the department. Our advice to chairs regarding these capabilities comes with two caveats. The first is that science leadership content knowledge, while underrepresented in the literature, is critical if a chair is to establish credibility for any reform proposals. One of the major issues that plagues the implementation of many reforms is that they appear disconnected from the work of teachers. Teachers place great store in credibility, and the best way to build support for any reform is to allow teachers to see the reform in practice. The second issue is that we, as science teachers, will never possess all knowledge in these areas, nor should we be expected to. If we are to reimagine the department, we need to be aware of our

Figure 3.1

CONCEPTUAL MODEL OF LEADERSHIP CAPABILITIES CONTRIBUTING TO SCIENCE INSTRUCTIONAL LEADERSHIP



Source: Peacock 2014, p. 43

strengths and limitations and work from where we are. Paralysis through analysis serves no one, least of all our students and colleagues. We learn by doing and (hopefully) from our mistakes, so these capabilities evolve over time, reflecting changes in our own knowledge, the impact of mandated changes, and the changes that occur in departments as teachers also learn. The important point is that the capabilities focus us on what is important in different yet interconnected aspects of our work as chairs. So, let's take a closer look at each of the capabilities.

Science Leadership Content Knowledge

It should be obvious that a chair possesses a comprehensive understanding of science, but in saying that we open up an important issue that is sometimes ignored. Reform documents such as the *NGSS* are clear that discrete knowledge of science concepts is no longer sufficient. Teachers must be more than content specialists—they should *also* be learned generalists with the capacity to link science to the world in which they and their students live. The NSTA position statements also increasingly reflect this growing change in emphasis. For example, read the statement "Quality Science Education and 21st-Century Skills" (NSTA 2011). This is a call to recognize and value the personal practical knowledge that all teachers bring to

their work. Personal practical knowledge, derived from experience within both the profession and general life experiences, is foundational to teaching.

For chairs, this leadership capability centers on three factors. First, they should possess, and be constantly refining, their reform-based expertise in science content, the teaching and learning of science, instructional strategies, curriculum, and assessment. As the new NSTA position statement on the *NGSS* makes clear,

> *implementing the NGSS requires that experienced teachers make a significant shift in the content and manner in which they have been teaching and that beginning teachers make a shift from how they were taught at the university level. For many teachers a modification in the content knowledge and competencies will need to be made. (NSTA 2013)*

This expertise builds credibility and allows other teachers to see what reform-based instruction looks like. Second, establishing credibility allows the chair to start influencing departmental curriculum and instructional and assessment decisions. This influence arises as the chair begins to facilitate reform-based learning opportunities for their teachers in areas such as instruction, curriculum, assessment, and student learning. Finally, if a chair is developing this capability, then he or she is in a better position to discern what is an educational fad versus what changes need to be made to improve student learning in every classroom.

Advocating for Science and Science Education

The links between departments and faculties of science have had a great influence on the historical development of departments. In 1950 Rinker expanded on these connections, suggesting that chairs should develop and maintain links to science in the wider community and be prepared to act as advocates for science. This is an important capability for three reasons. The first is that the development of links between the department and the wider scientific community opens opportunities for students to see science as occurring beyond the classroom. The NSTA position statement "Learning Science in Informal Environments" states:

> *The learning experiences delivered by parents, friends, and educators in informal environments can spark student interest in science and provide opportunities to broaden and deepen students' engagement; reinforce scientific concepts and practices introduced during the school day; and promote an appreciation for and interest in the pursuit of science in school and in daily life. (NSTA 2012)*

Secondly, chairs can advocate for science, the teaching and learning of science, and increased public understanding of scientific concepts. This is particularly important when confronting issues that may be contentious within society but not within the scientific community. The actions of the Dover Area School District biology teachers who refused to read the statement that "Because Darwin's theory is a theory …" in 2004 is one of the more extreme examples of teachers having to advocate for their discipline and profession.

Finally, to lead reform, chairs need to be actively engaged with developments in science education. Engagement is vital because it provides a frame of reference to gauge the position and performance of the department relative to what is being mandated by the reform documents. The relationship between science, science education, and society has changed. Without an understanding of those changes, and an awareness of the alternatives to what currently happens in their departments, chairs may not be able to see beyond their concerns with the covering of the curriculum to the wider issues that they should be addressing.

Building a Collegial Learning Environment

A collegial learning environment is far more than a place where teachers enjoy the company of their colleagues. Chairs have the key role in shaping departments as places where teachers share a responsibility for the continuous improvement of student achievement. Such an environment has three characteristics, the first of which is the need for a focus on both teachers' content and pedagogical knowledge and students' ways of learning content. Second, there must be opportunities for teachers to engage in active learning through activities such as mutual observation and critique, the collaborative implementation of innovations, and opportunities to review student work and assessment and communicate these to other teachers. Third, learning opportunities need to be coherent with what teachers already know and work from that point to move toward the ideals of reform documents such as the *NGSS*. A collegial learning environment is one in which teachers are prepared to learn how to analyze their own and each other's instructional strategies, consider the links between teaching and learning, and experiment with alternative instructional and assessment strategies. To develop a department along these lines requires the chair to take a leading role in modeling these qualities while also being aware of the context in which their department operates.

Negotiating Context and Problem Solving

Chairs are impacted by a range of sociopolitical forces (and their attendant values) including those that operate within the school, the national education policies, and the complex range of forces that are conveniently grouped under the banner of globalization. All of these have some effect on the work of the department. The challenge for the chair is to negotiate through these forces and simultaneously work to improve teaching and learning and meet the demands of policy. This is never an easy task, and there are times when the wrong decision will be made. The best advice that we can offer is to work with your department to make the most morally defensible decision that can be made in support of any movement toward the ideals of the reform documents. Sergiovanni (1992) has described five bases from which leaders can draw their power: bureaucratic power, based on rules and regulations; technical-rational power, based on the leaders' knowledge of the field; psychological power, based on knowledge of human relations; professional power, based on professional norms and standards; and moral power, based on clearly enunciated values and the shared norms of a community. In part, leadership involves making political decisions and having the power to carry them through, and the chair who maintains a moral presence is more likely to shape the department as a community committed to improving teaching and learning and reimagining the department toward the ideals of the reform documents.

Peacock's model gives us an understanding of the capabilities that chairs need to bring to, and continue to develop in, their role. Leadership is about people, and the capabilities that we have discussed here all contribute to developing the conditions that allow departments to act as places for teachers' long-term professional learning. How those capabilities can be brought together as a coherent whole is the focus of the next section.

The Department and Leadership

One of the key principles that directed the writing of this book is the belief that individual science teachers struggle to align their work with the practices outlined in documents such as the *NGSS*. In saying this, we are not questioning the commitment of any science teacher; rather, we understand that the academic traditions the overwhelming majority of us have been socialized into make it profoundly difficult for us as individuals to make the sorts of changes to instruction envisaged by the reform documents. We also believe that departments, as both communities and organizations, possess many of the qualities needed to support the professional learning of all science teachers, and that the role of the science chair is crucial in realizing that potential.

Let us be clear, professional learning is more than the acquisition of knowledge; it is a preparedness to question current pedagogy and develop new instructional strategies that improve the quality of teaching and learning. Yager (2005) states that "the focus of teachers' learning should be one of inquiry into teaching and learning. This, of course, emphasizes the use of questions that leads to learning and the identification of possible answers" (p. 17). At its heart, therefore, the importance of the department to professional learning lies in its capacity to develop as a trusting environment in which teachers are free to question the teaching and learning of science. Such an environment provides

> *opportunities to voice and share doubts and frustrations as well as successes and exemplars. They need to ask questions about their own teaching and their colleagues' teaching. They need to recognize that these questions and how they and their colleagues go about raising them, addressing them, and on occasion even answering them constitute the major focus of professional [development]. (Lord 1994, p. 183)*

This quote raises two important questions: What does this environment look like, and is there some process to facilitate opportunities for learning? To answer these questions, we return to our conceptualization of the department as being a community and organization simultaneously. As we saw in Chapter 1, this dual conceptualization enables the chair to choose the appropriate cultural or bureaucratic strategies, or some combination of both, to pursue the aim of reimagining the department.

As a community, the department has a primary role in shaping teachers' instruction. This does not imply that all teachers in the department will share identical images of science or science education (see Wildy and Wallace 2004). However, as science teachers, they all share a particular identification with the discipline and subject. It is this common identification that serves as the starting point for conversations into the teaching and learning of science. The aim of these conversations should be to develop a consensus of what is important in science education and from there establish clear goals for teaching and learning. It is the development and communication of these goals that becomes the source of political power of the department as an organization.

In conducting conversations around the teaching and learning of science, remember that resources such as the *NGSS* and the NSTA position statements, work with board and state or provincial science specialists, and attendance at conferences can all provide valuable insights and supports for teachers and chairs looking to make changes to their instructional and assessment strategies. There is no justification for reinventing the wheel. Without input from outside the department, there is a real risk that conversations can be used to reinforce the status quo. Therefore, the chair

must be prepared to use the position to shape the conversation toward the goals of the reform documents and his or her vision for the department.

Transactional Leadership

The initial steps in shaping the department as a community involve understanding where teachers are in their professional (and to some extent in their personal) lives, their understanding of teaching and learning, and their learning needs. Initially, this may well involve the chair in self-interested exchanges with self-interested others and being prepared to bargain with teachers whose "interests and claims serve their own goals primarily, and only secondarily, if at all, serve the interests of the organization" (Starratt 1999, p. 26). Realize that there will always be some teachers who are set in their ways and reluctant to change, if they will change at all. As chair, you will win some, and you will lose some. Don't take it personally and never lose sight of the bigger picture.

The leadership literature refers to this as transactional leadership, and it is really about establishing the ground rules by which teachers can participate in the work of reform. This form of leadership is concerned with the bureaucratic issues of supervision and organization to promote "a routinised, non-creative but stable environment" (Silins 1994, p. 274). In establishing these ground rules, there must be a commitment to values such as integrity, honesty, trust, wisdom, and fairness and to the needs and rights of all involved. Central to these conversations must also be a sharing of instructional strategies and beliefs with other teachers and a constant message that the student success in learning and assessment tasks is the absolute priority in everything the department does. Setting the ground rules through transactional leadership is an important first step in shaping the community, but it will not by itself lead to long-term commitment, and there will be times when the chair will have to revisit the ground rules. Teachers come and teachers go, and as issues arise, the ground rules will need to be reset. The importance of transactional leadership is that it sets the stage for the department to move beyond being a collection of science teachers toward being a community of science teachers who are prepared to reconsider their instructional strategies in light of the reform documents. This brings us to what is known as transitional leadership.

Transitional and Transformational Leadership

To effect long-term change requires personal commitment. Teachers need to know that the chair is supportive of them and their work; the chair must establish a "moral presence" (Starratt 1999). Such a presence is grounded in how the chair works with

his or her teachers and must reflect the virtues of honesty, courage, care, fairness, and practical wisdom. The conduct of the chair is crucial in building respect and a sense of loyalty, both of which are foundational to any movement beyond transactional leadership toward transitional and transformational leadership.

Transitional leadership moves beyond the stability of transactional leadership and begins to challenge the status quo of individual and departmental teaching and learning. It does this by beginning to draw on the (perhaps latent) abilities of teachers to create new standards of expertise and collegiality, shared values and beliefs, and a shared commitment to the work of the department. It is this shared level of commitment that gives the department its political power. A strong department is one that is characterized by "individual and communal empowerment … involves the gradual embracing of responsibility for one's actions. It involves autonomous individuals in the choice to be active, rather than passive" (Starratt 1999, p. 29).

It is also one in which the difficult decisions that often have to be made about teaching and learning and issues such as resource allocations can be made in an informed way. The conduct of the chair continues to be crucial at this stage for a number of reasons. Teachers need to be able to trust in the chair that it is acceptable to make and learn from mistakes. The realignment of relationships (e.g., from individualistic teacher to colleague) and the professional conversations that underpin that realignment must be based on honesty and care. For teachers to move beyond the pedagogies that have served them well in the past and to embrace new pedagogies is an act of courage. It is also a stage that is risky and cannot be rushed. Starratt (1999) suggests that the transitional stage may take two to four years. In our experience and working with other chairs, this time frame may be on the optimistic side. Sustained over a period of time, transitional leadership can take on aspects of transformational leadership, which

> *seeks to unite people in the pursuit of communal interests. Motivating such collective action are large values such as community, excellence, equity, social justice, brotherhood, freedom. Transformational leaders often call attention to the basic values that underly the goals of the organization, or point to the value-laden relationships between the organization and the society it serves. Transforming leadership attempts to elevate members' self-centered attitudes, values and beliefs to higher, altruistic attitudes, values and beliefs. (Starratt 1999, p. 26)*

Given that one of the main objectives of reform documents such as the *NGSS* is to overcome the growing distance between an academic science education and contemporary students, we believe that transformative leadership at the departmental level is crucial. Only when teachers understand the need to change, are presented with

viable options for change, and work in an environment where they can safely take on an increasing personal responsibility for shaping and living the values and interests of reforms will change be sustained. We would caution, however, that the shift from transactional to transitional and then transformative leadership is never linear; there will be movement backward and forward. Departments are never static, so the chair must constantly be proactive in developing opportunities for teachers to revisit and renegotiate what is important to them as a department in light of their growing expertise in working with the reform documents. This requires knowledge of the predominant departmental structures that exist for contemporary science departments and how those structures can influence leadership.

Departmental Structure

Busher and Harris (1999) have investigated the structure of departments and the implications of those structures for the leadership of the chair. Of the five structures they describe, two are of particular importance to science. Both structures are characterized by having a number of teachers and access to a range of resources. The first structure, the "unitary" department, is more likely to be found in smaller secondary schools in which there is a limited differentiation of science into its component areas. In such departments, the chair can exercise a strong and direct influence on the teaching and learning that occurs. The other structure, the "federal" department, is more likely to be found in larger secondary schools and may consist of specialized subject leaders tasked with shaping teaching and learning for their specialization under the aegis of the department. In a federal department, the chair needs to supervise and coordinate the work of these specialist leaders within the framework of the whole department. Federal departments generally work because "their subjects and pedagogies are perceived as cognate and their cultures are substantially homogeneous" (Busher and Harris 1999, p. 309). The different structures, however, clearly place different leadership demands on the federal chair compared with their unitary counterpart.

Unitary departments, given their generally smaller size, require leadership from the chair that balances and prioritizes the needs of various courses within the science program. This requires a level of skill in dealing with political demands for resources and developing the formal and informal strategies for coordinating teaching and learning with the needs of students. In contrast, federal departments require leadership at both the specialization and department level. Important factors to consider with these departments include the history of the department's development and the consequent impacts on the formal and informal distribution of both power and authority. It is not difficult to visualize a long-serving teacher

in an area both possessing and being willing to use their influence to protect or promote the interests of their specialization. In an earlier work, one author of this book reported on a chair who acted as a mentor for a teacher who subsequently became a chair:

> *Will related that the teaching of school science in the mid-to-late 1960s was rigidly organized into scientific sub-disciplines: "I was a biology guy, and my first departmental chair was a physics guy—physics guys and biology guys don't think the same way, and we don't pretend to." This siloing of knowledge was obvious to Dan when he started teaching in 1982: "Teachers guarded their territories within science. So a physicist was a physicist, a chemist was a chemist. And we had grade nine and ten courses that you had to teach, but you always taught it from your perspective. It was a big competition, I think, to see whose science was best and where the kids ended up. Which science will they pick?" (Melville and Bartley 2010, p. 812)*

If working in a federal department an important point to note is the extent to which the chair, at the center of the department has, and is recognized to have, sufficient power to lead. Without power to effect change, leadership will not happen. And that brings us to the final section of this chapter, the relationship between chairs and those external decision makers whose demands so often impact the work of the department.

The Chair and External Forces

As we all know, reforms in education often appear to come and go, and the more cynical among us believe that the more things change, the more they stay the same. Science education has not been immune to this, and reform efforts have attempted to respond to the growing disconnect between science, science education, and society by explicitly outlining how teachers and their classrooms need to change. Given the resilience of the academic tradition in science, we could argue that documents such as the *National Science Education Standards* and the *NGSS* have been very good at saying *what* should be taught, yet have fallen short in understanding the *how* of enacting and supporting these reforms. This is particularly important for chairs because they are often under pressure to simultaneously provide instructional leadership in the department while implementing a range of curriculum and administrative changes. These changes can come from the school, board, state, and national level, and sometimes appear contradictory to the teaching and learning of science. How the chair responds to (or positions him- or herself in relation to) these external forces is crucial

if the department is to maintain a focus on improving the teaching and learning of science. To consider how chairs can position themselves in relation to reform initiatives, we turn to the work of the French sociologist Pierre Bourdieu.

The position of the chair to reforms is influenced by both their personal dispositions to the reforms and what the department as a community and organization sees as good science teaching. For most departments, this is a continuing attachment to the traditional script. The strong personal and professional relationships found in departments allow them to be considered social spaces or "fields" (Bourdieu 1990). Fields can be conceptualized as specific social environments "with explicit and specific rules, strictly delimited in … time and space" (Bourdieu 1990, p. 67). As social constructs, fields are made up of individuals who share common beliefs and practices and compete for symbolic and material products or "capitals" (Bourdieu 1984). Extending the concept, schools, boards, and reforms such as the *NGSS* can all be seen as fields with their own particular rules, priorities, and values. These fields are never independent of each other—they all overlap and exert an influence on teachers and classroom teaching and learning. Fields come into conflict and competition when what is valuable to each is challenged. If a reform is seen to challenge the instructional strategies that are valued by a department (and are seen as foundational to the department's power and prestige), then the reforms will be resisted. That resistance can take many forms, from rejection to co-opting the reform to the values of the department. Alternatively, a reform that is seen to reinforce the values of the department will be accepted. To a large degree, the response of the department to reforms relies on the leadership of the chair and his or her ability to understand the relationships between the "power structures, hierarchies of influence, and … practice" of both the department and the reform (Lingard and Christie 2003, p. 320).

In working with 12 science chairs in the southeast United States, Peacock (2013) identified two major constraints on chairs as they sought to understand and implement external reform efforts. These are important to understand in terms of highlighting the pressures that chairs face and the courses of action that are possible when dealing with reforms. The first constraint was how a chair's school context shaped his or her capacity to act as an instructional leader. Specifically, their position within the school leadership hierarchy constrained their leadership. Four types of leadership were identified: the chair as liaison, informal shared leadership, formal shared leadership, or the chair as autonomous leader. At one end of the hierarchy, the chair as liaison implements school (or board) administrative initiatives within their departments. In the second group, chairs who have negotiated greater authority exert a more active influence on instructional practices. The third group possesses a formal leadership position that gives direct access to school-level

decision making. The final group enjoys some level of autonomy from school-level administration in shaping the direction of their department. In presenting these groups, we are aware that the chair's position within the hierarchy of the school is not fixed, since changes within senior administration, staffing, and the changing issues that a chair faces can (and do) affect relative positions in the hierarchy and the responses that are required of them.

The second constraint was the influence of general education reforms on science chairs. Rather than seek to engage with science reforms, chairs were spending their time and effort addressing questions of assessment, accountability, and school improvement. Consequently, they were limited in the leadership they could provide in support of science education reforms.

We can learn from the experiences of the chairs in this study through a consideration of their words. To do this, we would like to offer a short vignette (drawn from Peacock 2013) from each of the leadership approaches we have described in this section and how they attempted to connect the work of their department to the wider reform efforts in science education.

Brad: The Chair as Liaison

Brad saw his role of chair as a liaison whose principal duty was to "push the administrator's agenda" within his department:

> *There was a big push in the district for teaching science with inquiry. I was pretty excited about the possibilities [and] initiated a program in which a group of teachers would go through the curriculum and identify specific ways to infuse inquiry-based strategies into the district curriculum. The group worked very hard trying new things, planning activities, and discussing outcomes. Ultimately, it all fizzled. Administrators and teachers ultimately didn't buy into the effort. I have come to believe that good standardized test scores are really all that matters to the bureaucracy. If the test scores in the paper look good to the public, initiatives from the grassroots aren't going anywhere—even when they would be good for students.*

Consider Brad's position for a moment. He was excited about the teaching of science as inquiry and had the freedom to initiate a program that encouraged teachers to try new strategies. And yet, in his own words, the effort ultimately "fizzled." But why? Have you, or your department, ever been in the position to enact a district agenda and given the resources to do it? What happened, and more importantly, why did it happen? What is the responsibility of the chair in such a situation? We would

suggest that, when implementing a district (or state) agenda, how you view the role of the chair is crucial. In this vignette, Brad saw his role as implementing the district agenda rather than as an instructional leader. Consequently, his understanding of the reforms and how they could be translated to the classroom was limited. While Brad viewed the inquiry initiative positively, he had not instituted the change and did not display a long-term commitment to transforming science teaching. Second, Brad appeared to lack both the time and influence to challenge the teachers' and administrators' perceptions of the reform. To challenge the status quo requires power and influence to be wielded for considerable lengths of time: a one-year appointment is not credible. Further, the strategy that Brad implemented indicates a limited capacity to integrate the work of the department and the reforms. Without a strong understanding of the reforms, the decision to "go through the curriculum and identify specific ways to infuse inquiry" indicates an oversimplification of the complexity of inquiry and teacher professional learning. Similar concerns will arise with the *NGSS* and its emphasis on practices. What can you learn, or need to learn, from Brad in terms of your understanding of reforms and how to introduce them to your department?

Charles: Informal Shared Leadership

Charles was in the position of, having been elected to the position of chair, also being responsible for conducting the school teacher performance evaluation process. Within his school, elected chairs experienced little support from school administrators. The teacher performance process was seen as poorly designed, with positive ratings being perceived as doing well due to the teacher's efforts, while negative ratings were perceived as punitive and not the responsibility of the teacher. The net result was that long-term professional learning was not encouraged. Consequently, Charles saw the role of chair as intensely political, balanced between influencing and alienating the teachers in his department. Charles also reported that his main concerns as chair were laboratory and chemical safety and student participation in science fair competitions. Important as these are, they are not reform issues. For Charles, the implementation of the *NGSS* was reduced to a question of content: "We will need to rework our curriculum maps …" Charles did discuss several examples of instructional leadership within his department. In particular, he attempted to introduce teachers to a series of board-mandated content literacy strategies:

> *I'm going to target the ones who are struggling. Now, you have to be very subtle because I don't have any ability to make anybody do anything. I can give [poor ratings] now and then, but it's just punishment; the rating system is not designed very well. The teachers will just say, "We*

> *don't want you anymore." As I've been trained in the reading across the content area, I can take some of those literacy strategies and say, "Hey, let me show you this." I'll just show it to them, and then they try it, and they'll talk about and say, "Well, this was the problem." What I'm trying to do is repair the places that I think need repair, whereas they will try the strategy and then forget about it.*

Charles believed that his work as chair was limited by the "top-down approach from the central office" in which administrators directed a series of general literacy and assessment initiatives. Charles' position is more common than we would like to admit and is a major source of stress and frustration. As a reality for many chairs, situations like these raise several issues. Before reading any further, what issues does Charles' dialogue raise for you? What are the leadership capabilities that need to be evident (or developed) in a situation like this? To what extent is Charles's perceived lack of influence indicative of a greater need to understand the department as a community? By this we mean that the chair needs to understand where teachers are in their professional (and possibly personal) lives, their understanding of teaching and learning, and their learning needs. Effective instructional leadership is based on an understanding of people, both teachers and students, and their learning needs.

Kim: Formal Shared Leadership

As a department chair, Kim occupied a formal position in the school leadership, with access to school-level decision-making processes. At the time of the study, the administration was focused on the use of student assessment data as a basis for decision making. Consequently, the focus of her work was closely aligned to the goals of the school, not the department. Her departmental leadership was evident in the operation of a STEM (science, technology, engineering, and mathematics) academy within the school and working with her district science coordinator in providing active support for science teachers.

> *As part of the STEM academy, I have been working to increase inquiry-based learning, depth of content knowledge, and reading and writing across the curriculum. The purpose is to get students to develop a deeper understanding of content material and to be able to communicate and apply those ideas to other areas. The* NGSS *will definitely add to the supporting framework to help all teachers improve mastery of standards, even if they are not in the labeled STEM courses. We will use the* NGSS *standards to provide an additional framework in conjunction with the* Common Core *standards.*

For chairs, who operate in the middle management of the school, this can raise a question of loyalties: to whom do you owe your loyalty, the school or the department? This question is fraught with danger, as Kim's vignette demonstrates. While Kim appeared to exhibit an understanding of science education reforms, including STEM and inquiry-based learning, there was a discrepancy between her words and the future of science education described by the reform documents. The first discrepancy was her approach to the reforms, which could best be described as mechanistic: "We will use the *NGSS* standards to provide …" The *NGSS* were portrayed as a checklist to prepare students to meet the *Common Core State Standards*, not as a long-term strategy for improving the teaching and learning of science. The second discrepancy was the unwillingness to challenge the academic script: The administrative focus was on assessment- and data-based instructional interventions, not on science education reform. Consequently, Kim mounted little challenge to tightly held beliefs, and the department remained on the periphery of science education reforms.

Fortunately, loyalty is not a zero-sum game, but it does require that chairs ask questions of themselves, their departments, and administrators. These can include questions such as the following:

- How can reform in the science department align with the aims and goals of the school?
- How do we understand student success in science, and how does that translate across the school?
- How can the professional learning opportunities in the department meet school-level professional learning objectives?

Melanie: The Chair as Autonomous Leader

Melanie was the chair of a department that had considerable freedom to chart its own course: "Nobody gets in our way much." With the support of her administrators, Melanie gave the teachers in the department the authority to pursue their own agendas. One outcome of this was the formation of a math–science academy within the school. Melanie herself took the primary lead for the physical science courses in her department, while relying on another teacher to lead the life science courses.

> *I went to one of the STEM programs that help with resources, and I started a robotics team because I'm trying to get an engineering design course this year. I'll be teaching that and going to camp with some of my students. We're also going to learn engineering design processes. ...*

> *The other teacher is doing something similar, but he wants to do more project-based teaching within biology, and so a few years ago we started a math–science academy. It is supposed to be a capstone project at the end, but we haven't been allowed the time for them to work on this.*

Melanie wielded considerable power in her efforts at instructional improvement, but her efforts did not represent a specific commitment to the reforms described in the *NGSS.* The changes within the department were somewhat superficial and lacked the coherence of the reform documents. Teachers, free to hold individual perceptions as to the meanings of the reforms, may implement changes consistent with the reform but are more likely to adapt the language of the reforms to their existing instructional strategies (Stigler and Hiebert 1999). To be a chair is to accept the responsibility for the teaching and learning of science within the department. This means that you need to make value judgments as to what is important, and then see these decisions through. There is no easy way around this. If you are to successfully reimagine the department, then *why* are the reforms important to you, your students, and your colleagues? Answering that question will help you shape a coherent response to the external forces that impinge on the work of all chairs.

Learning From These Chairs

What can we draw from the positions that these chairs held toward external forces? The first lesson is that chairs need to have a solid understanding of a reform before they attempt implementation. Although the *NGSS* documents recognize that it is the teachers' responsibility to enact professional autonomy, there is a focus on prioritizing the engagement of students with the science and engineering practices, disciplinary core ideas, and crosscutting concepts. To achieve this focus, it is necessary for the chair to understand and identify these essential framing principles of the *NGSS* so that as the department undertakes reforms (as with Melanie's math–science academy) the *NGSS* can serve as a compass and measure of success. Documents such as the *Educators Evaluating the Quality of Instructional Products (EQuIP) Rubric for Lessons and Units: Science* (NGSS Lead States 2014) can serve to help keep *NGSS* central to all design work and discussions around teaching and learning.

Without tools to help guide the work of reform, the risk of possessing a superficial knowledge is twofold: It will either not engender real commitment or will be misinterpreted and run the risk of becoming coopted into existing practice. Chairs need to have an understanding of how to wield power and position in the promotion of reform and have the ability to prioritize their efforts. They also need to have the capacity to operate simultaneously and strategically within, and across, both the department and the reform. This involves developing the leadership

capabilities that we discussed earlier: science content leadership knowledge, advocating for science and science education, building a collegial learning environment, and negotiating the context and problem solving. It is easy to write these words; it is much harder to live them, especially when faced with competing reforms. In the next chapter we start the journey toward putting these words into practice.

Summary

- The role of the science chair has historically been ambiguous. There is something of a consensus that the role involves a simultaneous focus on clerical duties, supporting students and teachers; and cultivating links to the wider academic, professional, and school communities.
- Leadership capability requires an integration of knowledge, practical skills, and personal qualities.
- For science department chairs, capability is required in four areas:
    1. Science leadership content knowledge
    2. Advocating for science and science education
    3. Building a collegial learning environment
    4. Negotiating context and solving problems
- Teacher professional learning is more than the acquisition of knowledge. It is a preparedness to question current instruction and develop new instructional strategies that improve the quality of teaching and learning.
- Departmental leadership is iterative, never static or linear. Depending on the context, chairs initially need to engage in transactional leadership, which sets the ground rules by which teachers can participate in the work of reform. Bureaucratic issues of supervision and organization need to be worked through at this stage. More importantly, chairs must demonstrate a commitment to values and the individual's needs and rights. Such a commitment is demonstrated in the sharing of instructional strategies and beliefs, and a constant message that the learning of all students is the department's absolute priority.
- Transactional leadership will preserve the status quo. If reform is to occur, then chairs need to draw on the abilities of teachers to create new standards of expertise and collegiality, shared values and beliefs, and a shared

commitment to the work of the department. This is transitional leadership and may take three or more years of work.

- Transformational leadership will only occur when teachers understand the need to change, are presented with viable options for change, and work in an environment where they can safely take on an increasing personal responsibility for shaping—and living—the values and interests of the reforms for the benefit of their students.
- The shift from transactional to transitional and then transformative leadership is never linear. There will be movement backward and forward. Departments are never static, so the chair must constantly be proactive in developing opportunities for teachers to revisit and renegotiate what is important to them as a department.
- Chairs need to understand the structure of their department and how that affects the politics of their work. Unitary departments require skill in dealing with the political demands for resources, and the coordination of teaching and learning with the needs of students. Federal departments require leadership that considers these departments' history and the distribution of both power and authority.
- The chairs' position within the school's administrative structure can shape the work of the chair. Chairs can occupy positions such as liaison, informal shared leadership, formal shared leadership, and autonomous leader. These positions are not fixed; changes in personnel and situation can affect the role of the chair.
- Chairs are also impacted by the time and effort required in response to general education reforms. These can limit the leadership that chairs could provide in support of science education reforms. Although chairs represent an important potential resource for supporting reforms, many chairs are seriously constrained in their ability to fulfill this potential.
- Chairs who are looking to reimagine their department need to have a solid understanding of a reform before they attempt implementation. Second, chairs need to have an understanding of how to wield power and position in the promotion of reform, and the ability to prioritize their efforts. And third, chairs must have the capacity to operate simultaneously and strategically within and across both the department and the reform.

Where Am I Today? Questions to Ask Yourself

For You as a Science Teacher

1. What does professional learning mean to me, and what responsibility do I take for my own learning?
2. How can I contribute to the professional learning of my colleagues?
3. What can I learn from my colleagues, and how can I establish those relationships?
4. In what ways might my actions around questions 2 and 3 help me to generate a culture of trust among department members?
5. What is my active involvement with professional associations such as NSTA?
6. What can I learn from the chairs whom I have worked with? What were their strengths and weaknesses? What would I do differently?

For You as a Department Chair

1. How do I see the role of the chair, and what do I really want to achieve over the coming year? the next three years? the longer term?
2. How do I prioritize my work as a chair?
3. What do I understand by the term leadership, and what do I need to learn?
4. What is the structure and history of the department? How do these influence the decisions that are made?
5. Who in the department possesses (and uses) power and authority? To what end is that power used?
6. What do I understand moral presence to be, and how would I seek to establish it?
7. What external forces do I have some influence over, and what is beyond my influence?
8. In terms of the leadership capabilities, what do I already do well, and what evidence is there for this judgment?
9. What leadership capability should I initially focus on developing? What resources will I need to develop my expertise in this capability?

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Reimagining the SCIENCE DEPARTMENT

If you want your science teachers to have the freedom and capacity to truly make their teaching more effective, *Reimagining the Science Department* is the book for you. It provides both the context and counsel to help you change the departmental factors that don't support teaching and learning.

Reimagining the Science Department will accomplish several tasks:

- Offer practical advice about strategies that will influence the teaching and learning of science within your department. This advice is strengthened by practitioner vignettes and appropriate research.
- Give you historical understanding of how departments have developed, how that has shaped their capacity to influence teaching and learning, why we teach science as we do, and why that perspective is being challenged and found wanting.
- Explain how the role of the chair has developed and can be refocused on developing the leadership capabilities that chairs should have to lead learning within the department.
- Provide suggestions for gaining the support of school administrators—support that is critical to any chair.

If you are already a department chair or aspire to become one, *Reimagining the Science Department* will help you understand the importance of the position and develop your ability to lead. School administrators or school board members will find it deepens the commitment to developing a department in which the practices of science are taught for the benefit of all students.

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