Leading the Transformation of Learning and Praxis in Science Classrooms

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ABSTRACT

Individual science teachers who have inspired colleagues to transform their classroom praxis have been labeled transformational leaders. As the notion of distributed leadership became more accepted in the educational literature, the focus on the individual teacher-leader shifted to the study of leadership praxis both by individuals (whoever they might be) and by collectives within schools and science classrooms. This review traces the trajectory of leadership research, in the context of learning and teaching science, from an individual focus to a dialectical relationship between individual and collective praxis. The implications of applying an individual-collective perspective to praxis for teachers, students and their designated leaders are discussed.

KEY WORDS: Teacher Leadership, Collective Leadership, Curriculum Transformation, Pedagogic Change, Agency|Passivity Dialectic

In her recent keynote address to Australian teachers, Judith Sachs (2007) argued that teacher leaders have the capacity to transform schools and influence the learning outcomes of students and the practice of their teaching colleagues. The emphasis on transformation is not surprising here given that the leadership literature has privileged transformational leadership in schools. The study of implementing technology curricula in primary schools in Australia, for example, led Léonie Rennie (2001) to conclude that "effective leadership and collaborative support promote change" (p. 64). Transformational leadership is congruent with cultural change with the focus being on "the people involved, their relationships" and the transformation of "feelings, attitudes and beliefs" (Hopkins 2003, p. 56). This implies that transformative teacher leaders empower staff, foster collegiality and shape shared vision (Busher and Harris 1999). These views are embedded in Jennifer York-Barr and Karen Duke's (2004) definition of teacher leadership as "the process by which teachers, individually or collectively, influence their colleagues, principals, and other members of school communities to improve teaching and learning practices with the aim of increased student learning and achievement" (pp. 287-288). At the time of their review, Jennifer York-Barr and Karen Duke (2004) noted that teacher leadership was under-theorised and that few empirical studies had been conducted. Since then, there is some evidence from the literature of a movement beyond descriptive research to greater attention to the advancement of theoretical notions of teacher leadership and leadership more generally. The purpose of this review is to identify these developments in the context of science education and forecast implications for practice, further research and theoretical development.

Just as designated leaders such as principals and department coordinators have responsibility for discharging particular leadership roles, leadership practices can be observed across a school (e.g. Ritchie et al. 2007). Science teacher leadership also could be realised

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within supportive professional networks beyond the boundaries of a school fence. These networks can be organised either as part of formal institutional arrangements or as informal non-institutional initiatives.

The Project for Enhancing Effective Learning (PEEL 2007) is an example of sustained leadership of teachers transforming practice within and across schools. PEEL was initially a two-year project in Australia in 1985 that allowed "teachers to act to change their educational ideas and practices. Change occurs through collaborative reflection on practice" (Baird 1992, p. 8). According to John Baird and Jeff Northfield (1992), "real change only occurs when teachers change" and pressure for changing teaching praxis came from the PEEL teachers' "personal dissatisfaction with what they were achieving with their students and the support for their efforts from colleagues expressing similar concerns and being willing to share ideas and experiences" (p. 293). For over two decades, PEEL has generated strategies and articulated principles for effective teaching for high-quality learning. PEEL's principles emphasise purposeful teaching procedures, sharing responsibilities for learning with the students and generating new pedagogical knowledge, while being supportive and collaborative with colleagues (Mitchell 2007). It has instilled a sense of community within the teaching profession both nationally and internationally. As a consequence of Galen Erickson's visit to Monash University, the first PEEL group was formed in a Canadian school in 1992, thus dispersing local initiatives from Australia to an international forum (see Erickson 2000). Other PEEL groups have formed in Denmark, Sweden and Malaysia. PEEL's effectiveness for influencing teaching practices is evident through the many contributions to PEEL SEEDS—a forum for PEEL teachers—that provide testimonials on how teaching practices have changed as a result of teachers' participation in PEEL practices and fora.

While there are numerous other examples of teacher leaders transforming pedagogy and curricula internationally (Elliott 1991; Spiegel et al. 1995), too many to review in this

chapter, very few studies deal with teacher leadership specifically. More commonly, reports (e.g. Tytler et al. 2008) recognise the importance of teacher leadership without defining what the authors mean by the term and the theoretical perspective(s) that shape their perceptions of leadership practice (e.g. Sachs 2007). To make an impact on the wider educational community, science education researchers will need to embrace the most recent theoretical work on teacher leadership.

As evident from PEEL, classroom teachers have the capacity to influence and transform cultural practices within schools. Students also have the capacity to influence what happens in their classrooms and schools, particularly in schools where organisational structures afford opportunities for shared, collective or distributed leadership (Lingard et al. 2003). Distributed (collective) leadership is a theoretical perspective that has received much attention in the recent leadership literature. I now consider the shifting emphases from individual to collective leadership discourses.

FROM INDIVIDUAL TO COLLECTIVE LEADERSHIP

Rather than reviewing the numerous studies of science teachers transforming their practice for their students, I restrict my attention to those studies that refer specifically to teacher leadership in one form or another.

Individual Perspectives of Leadership

When research questions focus on particular 'subjects' like department coordinators, principals and teacher leaders, the theoretical stance and research outcomes probably will be individualistic rather than collective. For example, in my first study of leadership practices (Ritchie and Rigano 2003), the focus was on what a particular department coordinator (i.e. Mr

Cresswell) believed and how these beliefs were enacted in his praxis. The theoretical standpoint was *collaborative individualism* that positions a teacher leader as one who tends "to be individualistic, collaborating with others intuitively and emphatically through shared vision of the possible" (Limerick and Cunnington 1993, p. 142), a stance somewhat consistent with Judith Sachs's (2007) thesis. Mr Cresswell demonstrated a personal commitment to professional learning and a caring ethic that he fostered towards learners, and he had contributed to the development within the department of a collaborative culture with other teachers who shared a vision for successful learning outcomes for their students.

Several international studies of individual teacher leaders have featured in the science education literature. In the USA, for example, Ann Howe and Harriett Stubbs (2003) reported three case studies of teachers who became teacher leaders through a professional development program that emphasised mutual respect, challenging tasks, the creation of a the community of practice, and the creation of opportunities for teachers to assume leadership roles. Rather than studying these teachers' leadership practices in situ (i.e., in their daily interactions with colleagues within their schools), however, the researchers accounted for their leadership development through the triangulation of data from interviews, observations of formal presentations and document analysis. Unsurprisingly, Ann Howe and Harriett Stubbs (2003) argued that hierarchical administrative structures within schools isolate teachers from influencing cultural changes that lead to school-wide initiates that improve student-learning outcomes. Without school structures that encourage professional interaction and collaborative support—as evident in Mr Cresswell's school, for example (see Ritchie and Rigano 2003) — Ann Howe and Harriett Stubbs (2003) argued that it is unlikely that teachers will develop their leadership capacities.

The teacher leaders studied in New Jersey by Nancy Gigante and William Firestone (2008) also were graduates of a teacher leadership program that prepared mathematics and

science teachers for in-school leadership roles for curriculum reform. These teacher leaders performed two broad functions in their schools: support and development. While three leaders engaged in only support (i.e. managing materials or preparing laboratories, building confidence or generating enthusiasm, piloting curriculum), four engaged in both support and development functions (i.e. designing activities or lessons, answering content questions, modelling or team teaching lessons, facilitating professional development) functions. They argued that the interaction of four contextual resources was needed for teacher leaders to make a sustained impact on their teaching colleagues. These included time to interact and coordinate professional development activities, administrative support to reinforce the role of teacher leaders, relationships with teachers, and coordination and reinforcement of professional development. Interestingly, these researchers acknowledged the importance of individual or personal enthusiasm of teacher leaders, but did not recognise enthusiasm or group effervescence as a product of successful interactions (see Collins 2004). Nevertheless, they asserted that "the improvement of teacher spirit can have far-reaching effects of retaining teachers and empowering them to improve their practice" (p. 312).

Canadian-based Brian Lewthwaite (2006) studied the experiences of three New Zealand teachers as they developed their capabilities as science teacher leaders during sustained school-wide science delivery improvement projects. These teacher leaders were interviewed via email about school-wide science delivery development projects in their elementary schools. As well as these interactions, all teachers at these schools responded to an online instrument called the Science Curriculum Implementation Questionnaire. Even though only one out of 49 items from the instrument mentioned leadership, the teacher narratives supported the following conclusions: collegial and professional support for the teacher leaders was important for the professional development of these teachers; and their development was dependent on personal, contextual and time factors.

Wayne Melville and John Wallace, also based in Canada, reported the leadership practices of four science teachers in one science department of an Australian high school (Melville and Wallace 2007; Melville et al. 2007). They analysed the individual teachers' interactions for adherence to assertions about teacher leadership from the literature. The results showed the teachers possessed dispositions that allowed them to accept positions as teacher leaders, and to contribute to the transformation of the department. In the case of each individual, Wayne Melville et al. (2007) argued that "leadership was expressed through their engagement with different aspects of the departments' work. The net result of these expressions was that the department made significant changes to its practices over the period of the study" (p. 471). While the researchers declared the department was the unit of analysis, individual rather than collective leadership discourses were dominant.

Collective Perspectives of Leadership

Despite the hegemony of individualistic discourses in the leadership literature, James MacGregor Burns (1978) asserted that "leadership is collective" (p. 452) because a web of relations are formed in organisations that bind leaders and other members in a social and political collective. As I show later, this does not devalue the importance of individual leaders taking action for the collective, but rather recognises that leadership is a relational construct that is not embodied in particular individuals. The term collective leadership is sometimes interchanged with related constructs such as shared and distributed leadership (e.g. Avolio et al. 2003). While I most recently have focussed on collective leadership, others have focussed on the theoretical development and application of distributed leadership.

As 'critical friends' to the principal and staff of a rural high school in Western Australia, John Wallace and Helen Wildy (Wallace and Wildy 1992; Wildy and Wallace 1997) observed significant cultural transformations to teaching and learning over a six-year

period that they attributed to "a greater emphasis on shared leadership, team building, consultation and responsibility among staff, often modelled in relationships with students" (Wallace 2003, p. 5). A distributed perspective of leadership, John Wallace (2003) argued, shifts the focus from the traits and agency of valorised individuals to "structurally constrained conjoint agency, or the concertive labor performed by pluralities of interdependent organization members" (Woods 2004, p. 6). De-centering the individual leader, a distributed leadership perspective "focuses on the interactions, rather than the actions, of those in formal and informal leadership roles" (Harris and Spillane 2008, p. 31), with the practices being stretched over personnel and other resources within the school (Spillane et al. 2001). Distributed leadership, then, empowers individuals and groups by concentrating "on engaging expertise wherever it exists within the organization rather than seeking this only through formal position or role" (Harris 2004, p. 13).

James Spillane and his colleagues from Northwestern University (Spillane et al. 2001a b 2004) are well known for their studies of distributed leadership in Chicago elementary schools. They have found that the execution of most leadership tasks involves multiple leaders, and that the extent to which leadership is distributed depends on the subject area. Interestingly, they found that leadership activity in literacy involves more leaders than in mathematics and science. More importantly, the critical question that focused their attention in each case study involved how leadership is distributed within the school.

James Spillane et al. (2004) identified three types of leadership distribution. First, collaborative distribution underscores the reciprocal interdependencies between individual teachers playing or feeding off one another; that is, each teacher's actions arise from interactions with other teachers that in turn fuel subsequent and continuing interactions. Second, coordinated distribution refers to tasks that teachers undertake separately or together in a coordinated sequence, usually where tasks are allocated and coordinated by the

designated leader. Third, collective distribution is leadership practice that is stretched over two or more leaders who work separately but interdependently; for example, this would be evident in co-principalships where each principal agrees on and performs their task responsibilities.

Starting from James Spillane et al.'s (2001) theoretical development, I conducted a critical ethnography of an academy in a large urban high school in northeastern USA with my colleagues Kenneth Tobin, Wolff-Michael Roth and Cristobal Carambo (Ritchie et al. 2007). Our theoretical standpoint considered the dialectical relationship between individual and collective leadership practices. For this reason, we moved away from identifying our position on leadership as distributed to avoid the inevitability of resolving the 'distributed by whom?' question, an important sticking point for us because the question assumes that, in organisations like schools, an individual is responsible for distributing leadership and ignores the possibility that collectives (e.g. teams of teachers) can engage in particular tasks jointly for the common good. We then returned to James MacGregor Burns's (1978) original notion that leadership was collective and proposed a tentative definition for collective leadership as the process by which members of the group, team, academy or school create structures[1] that afford the group accomplishing its goals. We noted that this definition was based in part on generalised social exchange theory (Seers et al. 2003) that "describes an emergent pattern in which individuals exhibit group-directed behaviours that are reciprocated by other group members; … [It] is multilateral, indirect exchange in which individual contributions are spread over time and across various group members" (pp. 85-86). From this perspective, generalised exchanges are likely to build group solidarity (Seers et al. 2003) or a feeling of membership and belonging (see Collins, 2004) because contributions are made with the expectation that returns will be spread over time and across members.

At the time of Stephen Ritchie et al.'s (2007) study the Science, Engineering and Mathematics (SEM) academy was in transition after being formed from two previous academies in a school-wide restructure and where the designated leader of the academy (i.e. Cristobal Carambo) had just been appointed after the recent promotion of the previous leader to assistant principal. The academy appeared to be split between two factions, each led by a candidate for the vacated formal position of academy leader. Loyalties were split and there was a tendency for teachers to conduct their work privately in competition with each other for scarce resources rather than collaboratively where resources could be shared for the collective good. Over time, the academy became more cohesive as teachers started to trust each other by sharing resources for collective use in the academy. These resources were not limited to material objects and included ideas for teaching and management of the academy.

The new academy leader accessed and helped to disperse information about effective teaching practices in the service of the collective interests of the academy. For example, he recounted the practice used frequently by a female teacher who successfully established a home-school partnership to a male beginning teacher (i.e. Bryant) who was struggling to gain respect from his students. The teacher regularly contacted parents by telephone to inform them of the progress and achievements of her students. This helped to reinforce the positive work habits of the students at home, as well as establish an effective communication channel with the parents. Successful interactions among teachers and among teachers and students built a sense of common purpose and belonging (or solidarity) among members of the academy, leaving them with positive emotional energy or enthusiasm to achieve new goals.

Sharing resources and ideas for teaching and learning need not be limited to an academy leader or teachers. In the SEM academy, students also contributed to discussions that focused on improving their learning. These discussions were named cogenerative dialogues because they were intended to cogenerate collective resolutions in regard to issues such as

outcomes, roles, resources and rule structures within science classrooms. Typically cogenerative dialogues included the teacher and two or three students, with each having responsibility for ensuring that all participants contribute ideas without regard to formal status within the school, ethnicity or gender. They could also be used in meetings between administrative staff, parents and their children and in whole-class settings.

In one whole-class cogenerative dialogue that I observed, students were keen to suggest ways in which classroom procedures could enhance their motivation to engage in planned activities. After this meeting, both students and the teacher were committed to enacting the resolutions that were intended to improve the learning outcomes for the students and the teaching goals of the teacher. Successful outcomes from cogenerative dialogues encouraged students to exercise their collective agency in other contexts when teacher practices and academy/school structures interfered with their learning. On these occasions, aggrieved students respectfully requested participants (e.g. teacher and class) to engage in cogenerative dialogue to resolve a perceived problem. In this way, the practice of cogenerative dialogue became more widely used within the academy with greater commitment from the collective to effect agreed resolutions.

From our research in the SEM academy, we found it helpful to extend typical meanings of distributed leadership and refine our tentative position on collective leadership. We came to think of collective leadership as involving shared responsibility of members to enact structures that afford agency to stakeholders. As well, we realised that collective leadership manifests not only as practices like cogenerative dialogues, but also as solidarity among participants and the generation of positive emotional energy through successful interactions.

This refined position on collective leadership was applied by Stephen Ritchie and colleagues (2006) to the cross-case study of leadership dynamics of science departments in two culturally different high schools from a provincial city in Australia. Each department depended on the collective resources produced by individual and small teams of teachers for the benefit of their respective teachers and students. The department coordinators acknowledged the importance of drawing on these internal resources as well as utilising selected external resources for the purpose of improving practices within their schools. They accepted individual leadership roles while being receptive of suggestions and ideas from others within their departments, particularly in relation to the preparation of units of work by teachers. In this sense, the department structures enabled multiple leaders to influence each other mutually for the collective good. In many ways, both coordinators enacted collective leadership practices that empowered all teachers to lead. Yet, it was acknowledged that designated leaders such as department coordinators experience privileged positions that afford them differential agency in shaping structures that encourage or constrain teachers' contributions to shaping these structures.

PRACTICAL IMPLICATIONS OF COLLECTIVE LEADERSHIP

As seen in the studies of collective leadership in science departments (e.g. Ritchie et al. 2006), collective leadership can manifest as teamwork. Self-selected informal teams, involving teachers who share ideas and resources for the development of units of work, might form temporally. Alternatively, even in hierarchically structured schools, individuals such as department coordinators might formally convene a working party within or across the department to improve particular structures that might enhance student learning. In both cases, human potential required for team capacity building is released and accessed as

resources for/by the team. Here teachers develop expertise by working together so that the leadership that emerges collectively is more than the sum of its parts.

As well as recognising that different structures between schools account for differential agency of teachers within schools to contribute to new structures, the following implications for designated teacher leaders (i.e. department coordinators) can be gleaned from these studies:

- Accept that leadership is not embodied within individuals but manifests in the interactions between individuals within collectives.
- Seek opportunities for teachers to contribute to important discussions about policy and practices so that individuals can access and share the collective human resources for the benefit of both individuals and the collective.
- Create structures that involve smaller teams of teachers to exercise greater agency of individuals and groups.
- Resolve contradictions through the enactment of cogenerative dialogues (or meetings between stakeholders to cogenerate collective resolutions — see Ritchie et al. 2007) so that individuals can exercise their agency to refine structures for the collective good.

FURTHER THEORETICAL DEVELOPMENT OF COLLECTIVE LEADERSHIP

As I alluded to earlier, it is difficult for me to embrace James Spillane et al.'s (2001 2004) stance on distributive leadership when they continue to refer to the leader-follower binary as an inevitable relationship in theorising leadership, particularly teacher leadership. In successful teaching teams, it is more likely that all teachers will 'lead' because they will contribute ideas and other resources to the team in order to advance the team's goals that in

turn will feed back on their practice. This is very different from one teacher leading while the others follow, or even a kind of turn taking in which each teacher takes a turn of leading and following. Nevertheless, teaching team members will need to contribute (i.e. agency) and be receptive to new and different ideas and practice from their colleagues (i.e. passivity) for cultural transformation to occur. While my previous research with collective leadership has applied the structure|agency and individual|collective dialectics, it now seems that the agency|passivity dialectic might be just as important for further theoretical development of collective leadership within schools.

Wolff-Michael Roth (2007) asserted that *passivity* (and the associated concept of *passibility*, the capacity to feel, suffer and be susceptible to sensation and emotion) "is at the very heart of agency and yet it is curiously absent from theorizing in the social sciences" (p. 2). He argued that passivity was central in explaining how constraints bring about differences between the enacted and planned curriculum in schools: "teachers are both agential and passive with respect to the ways in which the enacted curriculum unfolds. It is a collective process and product so that teachers also are subject to their conditions as much as they bring these about (and changes therein)" (pp. 7–8). In relation to a successful cogenerative dialogue between a teacher and her students, for example, a student might identify a problem to which the teacher was ignorant but, upon hearing and understanding the issue from the student's perspective (passivity) along with reinforcement from the other students present (collective agency), the teacher now works with her students (agency) to construct a joint plan for which everyone will be responsible for enacting. In so doing, all participants become attuned (or receptive) to how others perceive and respond to the new structures put in place, with this influencing their individual and subsequent actions.

To illustrate the recursive relationship between agency and passivity in collective leadership further, I turn to a planning meeting between Cristobal Carambo and the beginning

teacher named Bryant during the transformation of the SEM academy, as discussed

previously by Ritchie et al. (2007). When Carambo became aware (passivity) of escalating

negative emotional energy in Bryant's class, he convened (agency) a planning meeting with

Bryant. Carambo himself had become aware of another teacher's practice (passivity) of

telephoning parents about their children's progress. Carambo brought this practice to Bryant's

attention with the intention of improving Bryant's relationship with his students (agency). As

Bryant listened, he nodded in synchrony with Carambo's rhythmic gestures and speech

(passivity) before annotating the practice (agency) in his notebook, possibly for further action.

Without opening himself up for a suggestion from Carambo that might improve his

relationship with students, Carambo's agential move would not have made an impact on

Bryant and his practice. In turn, during the episode, Carambo detailed the practice as he

himself became aware of Bryant's growing receptivity to the suggestion, creating an

opportunity for both Carambo and Bryant to consider how this could be enacted in his

classroom (collective agency). Passivity and agency were both required for successful cultural

change and for their collective leadership to transform practice in Bryant's classroom and

become a resource that other teachers within the academy could access and use. Through this

post hoc analysis, and in light of this review, I can refine further my understanding of

collective leadership. *Collective leadership is the iterative and recursive process in which*

members of a group, team or organisational unit share responsibility for the generation and

enactment of structures that afford them agency and passivity for continuing successful

interactions through which solidarity and positive emotional energy emerge.

NOTE

[1] The term *structure* refers to the social arrangements, relations and practices that exert power and constraint over what individuals and groups can do, while *agency* refers to the power to act in social contexts by individuals and groups. The relationship between structure and agency is recursive because, through social interactions, each action reproduces and produces structures that become resources for further possible actions of participants. This dialectical relationship can be represented as structure|agency.

REFERENCES

Avolio, B. J., Sivasubramaniam, N., Murry, W. D., & Garger, J. W. (2003). Assessing shared leadership: Development and preliminary validation of a team multifactor leadership questionnaire. In C. L. Pearce & J. A. Conger (Eds.), *Shared leadership. Reframing the hows and whys of leadership* (pp. 143-172). Thousand Oaks, CA: Sage.

Burns, J. M. (1978). *Leadership*. New York: Harper & Row.

Baird, J. (1992). The nature of PEEL. In J. R. Baird & J. R. Northfield (Eds.), *Learning from the PEEL experience* (pp. 2-11). Melbourne, Australia: Monash University.

Baird, J. R., & Northfield, J. R. (Eds.). (1992). *Learning from the PEEL experience*. Melbourne, Australia: Monash University.

Busher, H., & Harris, A. (1999). Leadership of school subject areas: Tensions and dimensions of managing in the middle. *School Leadership & Management, 19*, 305-317.

Collins, R. (2004). *Interaction ritual chains.* Princeton, NJ: Princeton University Press.

Elliott, J. (1991). *Action research for educational change.* Milton Keynes, England: Open University Press.

Erickson, G. (2000). *PEEL: Fifteen years later and still going strong*, Issue 50, p. 109. Retrieved 1 June, 2008, from http://www.peelweb.org/index

Gigante, N. A., & Firestone, W. A. (2008). Administrative support and teacher leadership in schools implementing reform. *Journal of Educational Administration*, *46*, 302-331.

Harris, A. (2004). Distributed leadership and school improvement. *Educational Management Administration & Leadership*, *32*(1), 11-24.

Harris, A., & Spillane, J. (2008). Distributed leadership through the looking glass. *Management in Education*, *22*(1), 31-34.

Hopkins, D. (2003). Instructional leadership and school improvement. In A. Harris, C. Day,

D. Hopkins, M. Hadfield, A. Hargreaves, & C. Chapman (Eds.), *Effective leadership for school improvemen*t (pp. 55-71). London: RoutledgeFalmer.

Howe, A. C., & Stubbs, H. S. (2003). From science teacher to teacher leader: Leadership development as meaning making in a community of practice. *Science Education, 87*, 281-297.

Lewthwaite, B. (2006). Constraints and contributors to becoming a science teacher-leader. *Science Education, 90*, 331-347.

Limerick, D., & Cunnington, B. (1993). *Managing the new organization: A blueprint for networks and strategic alliances*. Sydney, Australia: Business and Professional Publishing.

Lingard, B., Hayes, D., Mills, M., & Christie, P. (2003). *Leading learning. Making hope practical in schools*. Maidenhead, England: Open University Press.

Melville, W., & Wallace, J. (2007). Metaphorical duality: High school subject departments as both communities and organizations. *Teaching and Teacher Education, 23*, 1193-1205.

Melville, W., Wallace, J., & Bartley, A. (2007). Individuals and leadership in an Australian secondary science department: A qualitative study. *Journal of Science Education and Technology, 16*, 463-472.

Mitchell, I. (2007). *About the PEEL Project*, 89, 6. Retrieved 1 July, 2008, from http://www.peelweb.org/index

PEEL. (2007). *Project for enhancing effective learning*. Retrieved 1 November, 2007, from http://www.peelweb.org/

Rennie, L. J. (2001). Teacher collaboration in curriculum change: The implementation of technology education in the primary school. *Research in Science Education, 31*, 49-69.

Ritchie, S. M., MacKay, G., & Rigano, D. L. (2006). Individual and collective leadership in school science departments. *Research in Science Education, 36*, 141-161.

Ritchie, S. M., & Rigano, D. L. (2003). Leading by example within a collaborative staff. In J.

Wallace & J. Loughran (Eds.), *Leadership and professional development in science education* (pp. 48-62). London: RoutledgeFalmer.

Ritchie, S. M., Tobin, K., Roth, W. M., & Carambo, C. (2007). Transforming an academy through the enactment of collective curriculum leadership. *Journal of Curriculum Studies, 39*, 151-175.

Roth, W.-M. (2007). Theorizing passivity. *Cultural Studies of Science Education, 2*, 1-8.

Sachs, J. (2007, September). *Teachers of the 21ˢᵗ century: Leading and learning for improvement.* Keynote address presented at Teaching Australia conference, Gold Coast, Australia.

Seers, A., Keller, T., & Wilkerson, J. M. (2003). Can team members share leadership? Foundations in research and theory. In C. L. Pearce & J. A. Conger (Eds.), *Shared Leadership: Reframing the hows and whys of leadership* (pp. 77-102). Thousand Oaks, CA: Sage Publications.

Sewell, W. H. (1992). A theory of structure: Duality, agency, and transformation. *American Journal of Sociology, 98*, 1-29.

Spiegel, S. A., Collins, A., & Gilmer, P. J. (1995). Science for early adolescence teachers (Science FEAT): A program for research and learning. *Journal of Science Teacher Education, 7*, 165-174.

Spillane, J. P., Diamond, J. B., Walker, L. J., Halverson, R., & Jita, L. (2001a). Urban school leadership for elementary science instruction: Identifying and activating resources in an undervalued school subject. *Journal of Research in Science Teaching, 38*, 918-940.

Spillane, J. P., Halverson, R., & Diamond, J. B. (2001b). Investigating school leadership practice: A distributed perspective. *Educational Researcher, 30*(3), 23-28.

Spillane, J. P., Halverson, R., & Diamond, J. B. (2004). Towards a theory of leadership practice: A distributed perspective. *Journal of Curriculum Studies, 36*, 3-34.

Tytler, R., Symington, D., Smith, C., & Rodrigues, S. (2008). *An innovation framework based on best practice exemplars from the Australian School Innovation in Science, Technology and Mathematics (ASISTM) Project.* Canberra, Australia: Department of Education, Employment and Workplace Relations.

Wallace, J. (2003). Learning about teacher learning: Reflections of a science educator. In J. Wallace & J. Loughran (Eds.), *Leadership and professional development in science education: New possibilities for enhancing teacher learning* (pp. 1-16). London: RoutledgeFalmer.

Wallace, J., & Wildy, H. (1992). Pioneering school change: Lessons from a case study of school site restructuring. *Planning and Changing, 23*, 192-207.

Wildy, H., & Wallace, J. (1997). Devolving power in schools: Resolving the dilemma of strong and shared leadership. *Leading and Managing, 3*, 132-146.

Woods, P. A. (2004). Democratic leadership: Drawing distinctions with distributed leadership. *International Journal of Leadership in Education*, *7*(1), 3-26.

York-Barr, J., & Duke, K. (2004). What do we know about teacher leadership? Findings from two decades of scholarship. *Review of Educational Research, 74*, 255-316.

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