Applying the wild triangle to teaching middle-tier science in a Queensland independent school

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Applying the wild triangle to teaching middle-tier science in a Queensland independent school

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Abstract

A group of four teachers working with middle tier students in one Queensland independent school took part in this case study. Two experienced primary teachers and two inexperienced secondary science teachers planned, taught, and evaluated a science unit over the period of one school term in the school's initiation phase of middle tier reform. The group did not engage in joint planning. The primary teachers and secondary teachers formed separate teaching teams. Individual teachers reviewed the unit and maintained their professional focus on planning for their students' next term. This paper presents the argument framing this interpretative case study about group, team, and individual organisational influences on normative teaching uncertainties. A follow-up study will invite the four individual teachers, after a 2-year period of working together, to reflect on their group, team, and individual experiences during that period in order to determine similarities and differences in their interpretations of group teaching context, student transitions from primary to upper secondary tiers, and science curriculum and its integration with other middle tier KLAs and in order to elicit their ideas about how future teaching groups can improve middle schooling practice in this milieu.

Introduction

In the Queensland independent school sector, the growth of a middle tier of education has coincided with a more general increase in the number of Preparatory to Year 12 (P-12) independent schools in Queensland from 1998 to 2008[1]. Despite a steady increase in the number of teacher education programs specifically addressing middle years in Queensland (from 11 in

[1]Source: Web search on 21 April 2009 from AISQ Website: http://www.aisq.qld.edu.au/files/files/SchoolLists/AllSchools.pdf

2004[2] to 20 in 2009[3]) and Australia (from 19 in 2004[2] to 29 in 2009[3]), demand for qualified middle years teachers has outpaced graduation rates. Instead, independent schools have employed teachers with formal qualifications in primary or secondary schooling in order to keep up with their desire to offer a middle tier (Main & Bryer, 2005). In the teaching of science in a middle tier, experienced primary teachers have often been grouped with inexperienced secondary science teachers to work with a cohort of students, to integrate curriculum, and provide authentic assessment.

This interim approach to staffing in Queensland independent schools has been a focus for many unstated expectations, assumptions, and beliefs about teacher flexibility, which have an unknown influence on the success of reform in this sector. Specialist middle tier teachers from new teacher training programs have been in scarce supply. Experienced senior science teachers have been somewhat unwilling to teach science in a middle phase. It has been argued that partnering teachers in blended primary-secondary groups captures and blends their relative strengths in whole-child pedagogy and science curriculum respectively (Whitehead, 2000). It has been expected that this blended teaching group would have active institutional support at school level and active structural support from team collaboration to usher a middle schooling educational culture (Luke et al., 2003) through its initiation phase (Pendergast et al., 2005).

An embedded assumption is that these teachers have been enthused by expectations about transforming instruction in the alternative reform milieu (O'Keefe, 2009). "Moreover, there appears to be a belief among government and industry stakeholders that teachers will implement innovations as directed. Yet such a view denies how teachers, like other workers, think, act and decide how to deploy their energies in the effortful activity of learning and changing their practice" (Billett, 2009, p. 1333). It has been pointed out that reforming different schools in Australian have persistently pursued different interpretations of reform (Main & Bryer, 2005; Aspland & Nicholson, 2003) that seem to share a belief in the resilience of teachers to deal with change expectations from their own resources. However, Main (2009) has argued that an imposed "top-down" approach to reform driven by policy and other external agendas of educational leaders

[2] Source: D. Pendergast (2005). The emergence of middle schooling. In D. Pendergast & N. Bahr (Eds.), *Teaching middle years: Rethinking curriculum, pedagogy, and assessment* (p. 13). Crows Nest, NSW: Allen & Unwin.

[3] Sourced by web search on 15 May 2009. Inclusions based on use of middle school/ing/years in program site.

may conflict with the "bottom-up" teacher establishment and dissemination of school culture (Main, 2009), bringing about tensions in the existing status quo built on its pattern of power relationships and customs (Sarason, 1990).

Australian studies of members of state-based professional teaching organisations have shown a relatively high proportion of teachers (20-30%) already working "out of field": They may be teaching (a) a level of schooling for which they have no formal qualifications or (b) a field for which they have no major or minor teaching qualifications. Recent data from surveys in Western Australia (McConney & Price, 2009) and Victoria (Ingvarson, Beavis, & Kleinhenz, 2004) have indicated higher rates of out of field teaching in independent schools, "hard to staff" metropolitan schools, rural schools, and less affluent schools. However, these studies have not provided a clear picture of "out of field' teaching in the middle tier.

An Australia-wide survey of staffing (DEEWR, 2008) classed middle teaching as Years 4-10 which covered both primary and secondary tiers and qualifications Although this class was too broad to show transfers into a middle-specific category of teaching, there was a note about some teachers working primary-secondary "middle" combinations. McConney and Price (2009, pp. 5-6) also noted that few teachers working in a middle tier participated in their WA study but commented that out of field assignment of teachers might cover real shortages and undermine the quality of teaching.

The combined strength of a group and the notion of blending were expected to create an internal momentum for change and stimulate shared problem solving. The general feeling was that grouping teachers encourages them to develop common goals, engage in activities to achieve them, and develop new cultural practices and social interactions to communicate with each other about these activities and their goals. For example, primary and secondary teachers could pool their reform ideas about (a) the educative needs of young adolescents, (b) the balance between generalist community-based and specialist discipline-based approaches to science education, and (c) the alignment of middle tier pedagogy and programming relative to primary and secondary tiers (Beane & Brodhagen, 2001).

Individual teachers' perspectives on how they conduct their everyday activities have been expected to accommodate multilevel changes in their patterns of teaching as a group in a new tier of schooling, as a member of a multi-partner team, and as an individual practitioner with

traditional identities linked to primary or secondary tiers of education. There was early recognition that some schools have engaged in "superficial reform" (Aspland & Nicholson, 2003, p. 36) rather than the expected holistic reform in which alterations in pedagogy and curriculum frameworks accompanied changes in student grouping and physical structure.

Aim of study

The present study followed a teaching group comprising two experienced primary and two inexperienced secondary science teachers working on a science unit over the period of one school term in a Queensland independent school. As the independent school in this study was in its initiation phase of superficial reform to provide a middle tier, the aim of this study was to study the teachers' work together as a group of four practitioners and the teachers' interpretations of conditions facilitating and hindering that work.

Framing Australian research on adding a middle tier

Table 1 shows the use of the three-part framework to the present study of a school term. The research framework of this study of a multi-partner teaching group followed the tripartite characterisation of Australian research into a middle tier into three phases of reform and a related three-step sequence of best practices. This division of the school term into three distinct but interrelated phases in line with this research framework was able to draw on expectations regarding the sequence of teacher actions during a school term. As Wheelan (2005) reported that teams take about two school terms to establish their working relationships, the study was focused on the third term, in order to study how the group performed the normal teaching routine of planning, implementation, and reflective evaluation of a science unit. For example, the planning phase of a term represents opportunities for teachers to initiate group planning of the unit and blend their strengths in the planning. Teacher actions through the term were then used as the medium for studying group, team, and individual facilitation of the unit.

Insert Table 1. Relationship between research frameworks and term teaching phases

Table 1 presented flexible rather than fixed relations between columns. Pendergast et al. (2005) identified three phases of reform (Initiation, Development, and Consolidation). The initiation phase implied non-superficial organisation of teacher collaborations. Main and Bryer (2007)

identified complementary research-based criteria of practice acceptance, effectiveness, and sustainability. Early acceptance of middle schooling practices featured in genuine reform implied non-superficial support and direction from school leadership and teaming (Main & Bryer, 2007). Within these frameworks, progress from reform initiation to the development phase and from teacher acceptance to effective implementation depended greatly on how teachers work together. Recent Australian studies have indicated that superficial initiation of a multi-partner group slows reform and that superficial acceptance of membership in a team undermines teacher practice in team-based pedagogy and assessment.

It was also noted that fixed time line of a school term contrasts with the longer and more flexible timelines of reform phases and practice sequences depicted in Table 1. That is, there was not a one-to-one relationship between the three-part term and three-part phases of reform change and effective teacher action in line with that phase. For example, Pendergast et al. (2005) noted that initiation might require a year or two, development might take the next 2 to 5 years, and consolidation could continue for a further 5 to 10 years (p. 64). Yet, genuine reforming investment in the first part of the three-part process (whether teaching a unit, initiating a whole-school reform, or accepting innovative teaching practices) represents a precursor to the way that teachers performed subsequent activities. In the present study, group-based actions in planning, teaching, and evaluating of a third-term unit (e.g., time allocation) would co-occur with related team-based practices and individual teacher actions through the weeks of the term and provide the basis for in-depth interpretation of how the teachers managed their context-dependent multi-level interactions (Dobson, 1999).

Deciding contextual features of a middle tier school-by-school

The present study adopted a minimalist definition of education for a middle tier between primary and secondary education. In line with the notion that this reform may take various forms on a continuum from superficial to genuine engagement in reform processes of changing curriculum, pedagogy, and student assessment (Aspland & Nicholson, 2003), schools have confused the term middle years and used it interchangeably with the terms middle school and middle schooling. Australian commentators have sought to make the point that it is the practices of schooling rather than the student age group and the school structure for this age group that are important to the

success of the reform. Chadbourne (2003, p. 3) commented on the problems of an elusive concise definition of middle schooling:

> Middle schools are designed to cater specifically for students in the middle years of schooling; that is, students in the middle of the developmental continuum from childhood to adulthood. They are also meant to be based on the philosophy of middle schooling. In practice, however, considerable variation exists across middle schools and it is questionable whether the philosophy of middle schooling applies solely to middle schools. These discrepancies need to be resolved to persuade sceptics that the rationale for middle schools and middle schooling is not flawed by lack of clear definition.

Dinham and Rowe (2006) also described middle schooling as "annoyingly nebulous – a slippery concept [that is] without a single definition and [that] appears to lack coherence" (p. 78). With a middle tier becoming widespread into Queensland independent schools, there is considerable scope for these schools to develop different understandings about the nature of the reform. Hence, any manifestation of education for young adolescents could be labelled as middle schooling.

Overlapping references to middle years, school, and schooling have provided a rationale for the minimalist use of the term middle "tier" to describe a educational program for young adolescents, between the traditional primary and secondary tiers: This term allowed for a wide possible range of expectations about and meanings for middle schooling practices in the teaching group. Middle years then referred to the age-grade student cohort. Middle school referred specifically to the provision of a separate building. Middle schooling referred to transformative approaches cognizant with accepted features and practices outlined in various Australian (Chadbourne & Pendergast, 2005; Chadbourne, 2001, 2003; MYSA, 2009) and US (Carnegie Corporation, 1989; Jackson & Davis, 2000; National Middle School Association, 1995) reports.

Guidelines developed by multiple stakeholders (e.g., middle phase advocates, government policies, educational foundations, professional bodies, and education researchers) have informed prospective exposure of Australian schools to middle schooling practice. These guidelines have included (a) principles based on Queensland research on barriers and facilitators of teaming in state–run middle schools (Main, 2007); (b) professional conversations about phase-specific practice disseminated by the Middle Years of Schooling Association Position Paper (MYSA,

2009); and (c) signature features of middle schooling recommended in the larger international and mainly American landscape (Carnegie Corporation, 1989; Jackson & Davis, 2000; National Middle School Association, 1995).

However, schools introducing a middle tier were making decisions about what the tier means for their school. As noted, schools have shown considerable variation in their reference to and interpretation of these guidelines as they introduce a middle tier. Whatever decision the school made and whatever formal changes to teachers' performance conditions ensued from this decision, its ecological re-arrangement placed expectations on these teachers. Yet, expectations were not always clearly articulated, and unintended consequences were not readily anticipated (Gump, 1980). Thus, the re-arrangement of the traditional practice of teachers working alone (Lortie, 2002) to working together did not guarantee transformation of the generally solitary culture of traditional practice and its valuing of professional autonomy.

Middle years

A school's decision to offer middle years education was to identify and label a student cohort as an institutional feature with no new ways of acting implied. The Middle Years of Schooling Association (MYSA) Position Paper described the term middle years as a time between ages 10 to 15, spanning the years of childhood to adolescence (MYSA, 2009, p. 1). With respect to the traditional two-tier school system of structures and professional qualifications, the middle years represented the time between primary and secondary year tiers of schooling. Main and Bryer (2007) stated that the most common age and grade ranges associated with middle years in Australia are 10-11—14-15 years and Years 6-9 respectively.

In Queensland independent schools, online surveying of school websites showed that the most common arrangement for middle years is Years 7-9[4]. Middle years might involve but not require some combination of separate buildings and distinctive programming. Chadbourne suggested that the considerable variation between schools requires auditing of its particular provisions beyond some age-grade tier. For the present case study of group, team, and individual teaching activities, specific conditions at one independent school were integral to the study.

[4] Source: Web search on 21 April 2009 from AISQ Website: http://www.aisq.qld.edu.au/files/files/SchoolLists/AllSchools.pdf

Middle school

A school's decision to offer middle school education was to identify and label the student cohort as a structural variation with new ways of acting implied. Chadbourne (2001) defined middle school as an "organizational unit or physical space separate from primary and secondary school, providing education for students in the middle years, which may or not be based on middle schooling principles" (p. 2). Similarly, MYSA (2009) defined middle schools as "structures allocated for specialist use by students in the middle years – middle schooling practices may or may not be pursued in these middle schools" (p. 1). This term was used in the present study to refer to the school structure created for middle tier students in an independent school and its organisational unit and physical space. Most independent schools in Queensland offering a middle tier of schooling have tended to provide some kind of purpose-built structure or a redesignated structure. For the present study, the presence of a separate school structure for the Years 7-9 student age group allowed for middle schooling practices but did not require them.

Middle schooling

A school's decision to offer middle schooling was to identify and label the student cohort as a professional variation with new transforming ways of acting made explicit. Barrett (1998) listed a suite of principles for Australian adoptees of middle schooling (i.e., learner-centred, collaboratively organized, outcome-based, flexibly-constructed, ethically aware, community oriented, adequately resourced, and strategically-linked). Pendergast (2006) described middle schooling as "a philosophical approach to education designed to cater for and be responsive to the developmental, psychosocial, and intellectual needs of early adolescents, typically aged from 11 to 15" (p. 13). Chadbourne and Pendergast (2005, p. 22) characterised this philosophical approach as "predominantly progressive, constructivist, outcomes-based, community-oriented, developmentally responsive, student-centred, liberal reformist, and contextually mediated". MYSA (2009) defined middle schooling as "an intentional approach to teaching and learning that is responsive and appropriate to the full range of needs, interests and achievements of middle years students in formal and informal schooling contexts" (p. 1).

Recognising critical mass of teacher practice for a middle tier

Beyond these efforts to distinguish the three terms, it has been recognised that Australian schools that have made an ideological shift towards reform can and do select a range of middle schooling

elements, practices, and principles to suit their particular context (Main, 2009). Recommendations stated in influential American documents such as *This We Believe* (NMSA, 1995), *Turning Points* (Carnegie Corporation, 1989), and *Turning Points 2000* (Jackson & Davis, 2000) initially required that reforming schools embrace all features of middle schooling. However, Chadbourne and Pendergast (2005; see, also, Chadbourne, 2001) advocated a pluralistic approach to middle schooling practice for reforming Australian schools rather than compliance with a true, completely holistic, and idealised model of middle schooling, thus avoiding the two extremes of "anything goes" and "all or nothing" (Chadbourne & Pendergast, 2005, p. 43).

Main and Bryer (2007) outlined an ongoing argument for a managed approach to acceptance of pluralistic reform matched to a school's context. They also cautioned that reform labels, whether "experimental reform" or "rigid orthodoxy", undermine an Australian school's capacity to sustain a pathway to reform. Main (2007) proposed that reforming schools engage in systematic introduction of practices to manage the change process. Main (2009) further argued that each school needs to commit to a change process and provide ongoing support to the teachers through processural changes to school culture.

Yet, there were potential problems in this notion of a pluralistic but managed approach. One basic problem was its nonspecific nature (i.e., what constitutes a critical mass of practices for initiating middle schooling reform and what constitutes systematic management of working through the initiation phase with or without practice acceptance). This lack of elaboration allowed opportunities for schools—either state-run or independent—to disseminate hopeful self-descriptions as having implemented middle schooling without informed planning and follow-up evaluation (Main & Bryer, 2007).

Another problem was the complex nature of change associated with this reform. Main (2007) argued that teachers can be double-loaded with developing programs and routines involved in setting up a new tier of schooling as well as with constructing new practices associated with middle schooling. When teachers working in a new school were new to teaching, new to specific science curriculum, and new to middle schooling practices, or some combination of these

unfamiliar aspects of middle years, they were likely to encounter much uncertainty about prioritising practices critical to the context and managing their introduction into the context.

Uncertainty has been described as an endemic property of teaching (Lortie, 2002), which teachers are expected to deal with as part of their role (Lange & Burroughs-Lange, 1994). The complex nature of the work and its focus on human relationships, as well as the lack of a knowledge base (e.g., defined goals) or technical culture (e.g., measurability of outcomes), has compelled teachers to rely on a mix of assumptions and personal motivations as the focus of their teaching (Helsing, 2007). This approach to teaching has contributed to teachers' anxiety (Hargreaves, 1994), which, in turn, engenders adopting various coping strategies or clinging to methods that worked in the past (Campbell, 2007, p. 2).

Understanding the uncertainties of teaching middle tier science

Because teaching has been about how to predict what will happen and deal with it in the classroom (Helsing, 2007), much discussion about educational reform and its difficulties has concerned ways to understand further changes to uncertainties and complexities of teachers' practice (Knight, 2009). Teacher practice in traditional primary and secondary setting has placed great value on routines (Knight, 2009). Knight (2009, p. 5) also argued that "attempt, attack, abandon" cycles of reform have failed in the past because practices have not been powerful and easy and because practitioners have not been supported to try to stick with new practices through direct coaching and indirect administrative supports.

Empirical studies of the guidelines for successful teaching in middle schooling have helped to make the case for the importance of system support for Australian teachers. Strong supports to the teachers have enabled them to work on transforming aspects of practice in this alternative milieu. Pendergast et al. (2005), who argued that effective teaching teams are a critical feature of Australian reform, identified a dip in performance of teaching teams during the initiation phase if the school does not actively support teachers during this phase. Moreover, Main (2007) also reported a need for active supports including ongoing training and common planning time to be provided by the organisational cultures in Queensland reforming schools.

A simple model of teaching uncertainties has revealed the complexities facing teachers asked to teach middle tier science. Ball and Forzani (2007) conceptualised teachers' interpretations of

events and interactions within a school milieu as part of a dynamic system of instructional processes. They used a simple symbolic representation of a model of education as a "wild triangle" within a circle (Ball & Forzani, 2007, p. 530). They identified teachers, students, content, and milieu as the four commonplace elements in all education in this model. They noted that these elements interact with each other in an instructional dynamic (see Figure 1). Thus, educational uncertainties in practice and situational occasions for flexibility and change arose routinely from variations in each of the common set of elements in this model. Interactions within the instructional dynamic were defined as the active processes of interpretation that constitute teaching and learning (Ball & Forzani, 2007, p. 530).

Insert Figure 1 Instructional dynamic

Inherent uncertainties (Helsing, 2007) within the elements of the instructional dynamic and their interactions provided the experiential basis for an implicit normative expectation that teachers are responsive to current dynamics and creatively improvise responses to shifting elements and relationships. Shifting allegiances and changing points of reference among the anchoring points of teacher, tasks, and students formed reciprocal relationships among elements; this loose anchoring of core elements of traditional teaching gave rise to acceptance of some typical instability in individual teachers-students-curriculum task interactions. Teacher work, therefore, involved reasonable expectations that teachers can work with a range of age levels in a range of settings to make creative adaptations of their practice and enthusiastically undertake new applications of their traditional practice; further extension has allowed both research-based reformers and administrators meeting various policy agendas to press teachers into service sometimes beyond their real capacity. Yet, superficial reform that grouped teachers together as member of a contrived group were perhaps "together but still alone."

Given these commonplace uncertainties in the instructional dynamic, it has been widely assumed that primary and secondary teachers are qualified to actively interpret the instructional dynamic of teacher-students-science curriculum content in a middle years milieu by adapting their professional experiences to the overlapping borders of the two-tier educational system (Ball & Forzani, 2007). When middle tier reform stimulated changes in teachers' roles and responsibilities, then teachers were expected to bring some flexibility to deal with new conditions. However, the model showed that reforming teachers' professional responsiveness to

instructional uncertainties faces variations to the wild triangle beyond the traditional range of known uncertainties in students, curriculum, and teaching method. Additional uncertainties involved differences between middle tier milieu and the larger independent school milieu (e.g., Yates & Holt, 2009), different kinds and levels of student interest in science (Goodrum et al., 2001; Tytler, 2007), and different views of a multi-purpose science curriculum (Kidman, 2008).

Hence, adaptation of the wild triangle to the present study of science education in the middle tier of a specific independent school provided a framework within which to interpret teacher actions. The middle tier version of these four elements in Figure 1 comprised content (subject matter = science curriculum), learners (students = early adolescents in middle phase), and teachers (pedagogy = primary and secondary teachers) within a school (milieu = middle reform). The location of teachers at the apex of this triangle allowed for this study's focus on teachers' perspectives on instructional activity during a unit of work. With this model, it was possible to visualise the way in which teachers interpret their own work and that of their colleagues and how they interpret some teaching-related aspects of their interactions with their students and science curriculum.

A mini-triangle at the apex of the wild triangle further unpacked teachers' pedagogical uncertainties. The group-team-individual aspects of middle tier pedagogy comprised a set of potential influences on the relative predictability or uncertainty of teacher interpretations of their instructional collaborations on a middle tier science unit. That is, teachers' prior identity as primary and secondary teachers, their current relationship with other teachers in a middle years setting, and the independent school's administrative support for their group were each separate but interrelated sources of potential unpredictability. This mini-triangle targeted teachers' flexibility in their own work, their teamwork with colleagues, and their work as a middle tier group. It also pointed to possible issues in their satisfaction with this work: What did they interpret as a sense of success in arriving at a new equilibrium in relation to classes, curriculum, and each other and what did they interpret as appropriate engagement in activities to establish middle schooling practices.

When a reforming milieu provided only superficial support for teachers, then it appeared likely that both instability and inflexibility become issues of concern. Experience and familiarity with traditional routines of practice provided some certainty and stability for primary and secondary

teachers teaching in their own milieu. However, working in an unfamiliar environment (e.g., a secondary school teacher or a primary teacher teaching in a middle school) provided an occasion to "tilt the wild triangle" in ways that potentially excite, accentuate, and exacerbate teachers' prior normalized feelings of relative certainty and tolerable uncertainty in their practice. Either way, it was possible that new demands on teachers' expertise and experience away from their respective traditional educational environment can tilt the wild triangle, destabilise the instructional dynamic, and undermine the initiation phase of reform.

Students and science education as core elements in middle tier uncertainty

As middle tier curricula became part of science teaching in Australia, it has remained unclear whether individual primary and secondary science teachers re-evaluate their pedagogical practices in line with implicit expectations about their new roles and responsibilities as middle tier teachers. In particular, it was unclear whether secondary science teachers adjust their pedagogical practices in accordance with a holistic view of adolescents and whether primary teachers reassess their instructional approaches to cope with the demands of disciplinary science teaching as part of middle tier science curricula. Moreover, it was unclear whether and how the prevailing culture of practice in the science subject affects primary and secondary teachers' adjustment to a middle tier environment. Rcently identified concerns about science education in the middle tier have included issues such as multiple demands of science education imposed by competing stakeholders (Fensham, 2006) and the philosophical and pedagogical differences associated with primary, middle, and secondary schooling (Jindal-Snape & Foggie, 2008).

Subject culture of science

It was possible that teachers from both primary and secondary backgrounds become novices in a field of middle schooling expertise (Hargreaves, 1986). For the primary teachers, it was possible that their unfamiliarity with the subject content knowledge of science and its particular discipline-based pedagogy engenders decrease confidence and feelings of comfort with the content. For secondary teachers, it was possible that familiarity in their subject content increases discomfort with integrated middle schooling practice. Given that secondary subject departments or primary educational environments establish the cultural basis of teachers' sense of professional identity (Grossman, Stodolsky, & Knapp, 2004), it appeared that primary and

seocndary teachers working in a middle tier milieu may experience more feelings of uncertainty, fear, and doubt and less sense of self-knowledge (Zembylas, 2003).

Inexperienced secondary science teachers appeared more likely to be vulnerable to additional uncertainties about their personal beliefs (Jones & Carter, 2007) than were experienced primary teachers extending their science teaching. Hargreaves (1986, p. 222) observed that induction into the cultures of an unfamiliar discipline brings a commitment and loyalty to the new subject and, in consequence, an erosion of commitment to other subjects. However, if superficial school-based induction did not foster this middle tier loyalty, then new science teachers appeared more likely to increase their loyalty to their "science teacher" identity. Thus, their views about science teaching as a professional and identities as a science teacher were of interest. Moreover, their views appeared likely to be visible in their interactions with their primary colleagues (e.g., either strengthening traditional loyalties to science teaching or transforming practices and beliefs about middle schooling).

Pedagogical content knowledge

It was expected that teachers' active interpretation of the instructional dynamic in teaching a science unit draws on their "pedagogical content knowledge" (Shulman, 1986), as well as their prior teaching history of curricular experiences, and science education allegiances. Pedagogical content knowledge or PCK was focused on a link between the world of the learner and its connection with the subject matter that enables teachers to structure content and create authentic learning experiences (allowing students to construct their own understanding of different concepts).

In the teacher-students-content instructional dynamic for all teacher practice (Ball & Forzani, 2007), middle tier teachers worked within anchoring points formed in previous practice and previous beliefs about instruction. Hence, it appeared that teachers' choice of practices in the alternative milieu may indicate shifting points in how these four teachers interpret (a) science as subject content, (b) middle school pedagogy, and (c) smooth student transition between earlier and later phases of schooling.

An interim mode of staffing in a middle tier in an independent school allowed latitude in the range of ways in which teachers can interpret and act on implicit expectations as individual practitioners; alternatively, it required guidance of group and team interpretations to find common ground among these teachers. Hence, teachers' accounts of practices chosen to work with each other in this alternative milieu might reveal aspects of the nature and limitations of this assumed flexibility. This case study addressed organisational factors operating at three levels: institutional (a superficially reforming school milieu of group-based teaching), structure (team of teachers collaborating on a science unit), and individual (teacher identity and related pedagogical content knowledge; teachers' prior backgrounds in traditional school and subject cultures).

Institutional organisation of middle tier group

For schools in the initiation phase of middle tier reform, innovative leadership has been viewed as a key factor in the progression through this phase (Pendergast el al., 2005; Main, 2009). Innovative leadership has been expected to encourage, support, and guide the acceptance of middle schooling practices including teaming (Pendergast, 2006). Strong and consistent leadership dispersed appropriately throughout the school provided support for staff and students. However, inadequate administrative support and training in middle years practices such as teaming was manifested in tensions that, in turn, hold back middle years reform (Main, 2009).

Given teachers' different profiles of professional competence and different senses of professional identity, Main (2009) argued that the organisational cultural model prevailing in a school affects collaboration on a shared new curriculum and related pedagogical issues of teaching and assessing students. In a case study in a Victorian High School undergoing a middle years reform, Yates and Holt (2009) also found that tensions between the dominant school culture and middle schooling values overshadowed more temporary issues such as lack of physical space and little time to implement curricular reform.

Structural organisation of a middle tier team

The practice of teaming has been identified as a signature feature of middle schooling reform (Pendergast et al., 2005; Main, 2007). Teaming was described as a non-negotiable key structural component of the establishment of a collaborative environment leading to more effective

interdisciplinary teaching programs (Pendergast et al., 2005). Main, Bryer, and Grimbeek (2004) described teaming as teachers working collaboratively to plan and teach together in small interdisciplinary groups. Main (2005) outlined benefits of teaming practices ranging from reduction in personal isolation; increases in motivation, personal enjoyment, and professional dialogue; and sharing of ideas and resources between teachers. Effective teaming practices were said to require reorganization and renegotiation of the relationships among teachers and between different communities of practice (Main, 2007).

The middle schooling practice of using small teaching teams that plan and teach together demanded some reshaping of multiple, complex, and inherently uncertain relationships among teachers. It appeared that teachers from diverse backgrounds have grounds for uncertainty about their roles. The role of group and team member created pressure on individuals to expend effort to construct shared meanings, but team formation needed social mediation, guidance, and explicit training. "Top-down" formation of teams has been aligned with administrative and teacher expectations that team members will develop a natural and harmonious relationship and form some kind of good teaching team. Main (2009, p. 18) reported that teams in three state schools, most of whom volunteered for this work, reverted from ideological acceptance of teaming at the start of a new year to more traditional "practical" arrangements by fourth term:

> At the beginning of the study, all teams reported collaborative planning, some team teaching, and collaboratively assessing. By the end of Term 3 that same year, no teams were observed team teaching, and planning in two teams was much less collaborative than at the beginning of the year.

Individual organisation of middle tier teachers

It has been argied that teachers' engagement of students in a meaningful and differentiated practice (in this case, middle schooling for science curriculum) depends on their willingness to participate in experiential learning as active members of multiple communities of practice (Wenger, 1998). Blending the relative strengths of primary and secondary teachers required collaboration between teachers as participating members of multiple teams. However, support and time to develop rapport and shared values affected this process (Wheelan, 2005).

Nias (1996) described how teaching is connected to teachers' sense of identity and self-esteem in their work. It appeared that teachers' sense of identity as primary-secondary-tier practitioners may help them resolve pervasive uncertainties in this alternative setting of their commonplace practice. Gee (2000-2001) outlined multiple orientations of identity, governed by the institution, allegiance to a group, perceptions of others, and human nature (p. 100). The interaction of these multiple identities—formed, sustained, and changed by the teacher's experiences and beliefs (Lave & Wenger, 1991)—provided a stabilizing platform on which to deal with the inherent uncertainties that come with these roles (Gee, 2000-2001). School cultures provided collective knowledge on which to draw. However, when reform changed their school tier and structural relationships with other teachers and expected individual teachers to change their role and responsibilities, then teachers' identities might experience unintended effects such as self-doubt and feelings of low efficacy.

Research questions

Four teachers' perspectives on patterns of group, team, and individual work were examined in relation to the typical ways in which these teachers conduct their everyday activities. It was proposed that events at each level of influence shape teachers' successful initiation of middle schooling reform. Teachers' interpretations of their experiences at each level (as a whole group, as members of a team, and as individuals) were the focus of this case study. Insofar as there have been gaps in institutional and structural aspects of reform at this school, teachers' perspectives on teaching in this middle years setting were expected to be individualistic and perhaps idiosyncratic.

There were three general research questions for this interpretative case study.

1. Group: How are the four teachers engaged in teaching science curriculum to middle tier students in this independent school being supported towards a middle schooling interpretation of practice in place of their traditional interpretations of practice?
2. Team: How are the two primary teachers and two secondary teachers working as a middle schooling team?
3. Individual: How are prior teacher identities as either primary or secondary teachers and present identities as middle teachers affecting individual interpretations of middle tier practice?

Methodology

Research design

An interpretive case study design (Andrade, 2009; Dobson, 1999; Yin, 1994) was employed for this study. Interpretive design allowed for investigation of multiple perspectives of the primary and secondary teachers involved in the study. This kind of study conducted in a natural setting was addressed to "how and "why" questions about the teacher's work with each other when blended in this way without clear supports for middle schooling practice (Andrade, 2009): Each teacher's view of their common task (teach science to students) and their "collaborative ecology" was important. These views were employed to build up a grounded theory within the case study boundaries systematically formed by the participants' view of the groups, teams, and individuals as they worked collectively or not throughout the term. This case study was designed to study how the teacher participants experienced change in a tangible situation (Meister & Nolan Jnr, 2001) as they negotiated the wild triangle.

This case study approach permitted "an empirical enquiry that investigates a contemporary phenomenon within its real life context, especially when the boundaries between phenomenon and context are not clearly evident" (Yin, 1994, p. 13). Bassey (1999, p. 60) stated that empirical enquiry of an educational case study (a) is conducted within a localised boundary of space and time; (b) into an interesting aspect of an educational activity, or programme, or institution, or setting; (c) mainly in its natural context and within an ethic of respect for the participants; and (d) explored significant features of the case and create plausible interpretations of what is found.

An interpretive approach to the case study also used the researcher's initial conceptualisation of and subjective interpretation of events as someone who has worked in a similar situation to produce a plausible account of interactions between participants with the social world (Andrade, 2009). Within an interpretive case study, a grounded theory approach (Glaser & Strauss, 1967) employing multiple data collection instruments was used to collect, analyse and interpret the data. Iterative analysis of the collected data within institutional (school and its reforming milieu), structure (team of teachers collaborating in science unit planning), and individual (teacher identity and related pedagogical content knowledge; teachers' prior backgrounds in traditional school and subject cultures) categories of middle years reform provided a basis for examining emergent issues in interpretation.

Research methods

Use of multiple methods (Denscombe, 2007) was consistent with a case study design to describe practice in this context. It was also consistent with a proposal in special educational literature that a continuum of research on effective practice matches different kinds of questions with different kinds of methodology (Odom et al., 2005). At one end of this continuum, questions aimed at interpreting participants' view of what is happening were likely to employ a qualitative approach in a naturalistic setting, with observational and focused exploration of practice in the setting and flexible methodology of sound quality. In the present study, matching of multiple methodologies of observation (participant and non-participant notes on lessons), interview (semi-structured focus group and individual), and personal reflective logs to phases of the school term enriched the account of practice in this milieu.

Demographic information obtained from participants' responses to a questionnaire assisted in developing questions for initial focus group interviews. Prior to these interviews, the four teachers were provided with initial questions, in order to direct their thoughts towards the upcoming interview and to serve as prompts during interviewing. The design of focus group and individual interview prompt questions employed the 5Rs Framework (Bain, Ballantyne, Mills, & Lester, 2002) of a reflective sequence of questions. Items asked for description of aspects of teaching (i.e., plan, teach, evaluate), immediate feelings, emotional interpretations based on past history and theoretical understandings, cognitive analysis of important aspects, and ideas about how to improve future teaching.

Individual/shared transcripts of interviews were made available to teacher participants for member-checking. Manual analysis of the data from focus groups, individual interviews, observations, and reflective logs employed a mix of grounded theory and discourse analysis to interpret the meanings teachers gave to their experiences in a middle environment. Also, automatic analysis by Leximancer software was used to check the interpretations without subjective bias.

Context

The independent school in this study (Valley College) provided a separate structure and a blended team to teach science (and mathematics) in its relatively new middle tier program. The middle tier intention was for the two experienced primary teachers and two inexperienced secondary teachers to work together on unit planning and to have subsequent informal and formal meetings throughout the term for reflection and further planning. At the same time, it was expected that curricular heads of department or program provided ongoing support for the development of teaming practices. The senior science head of department provided science-specific curriculum leadership in unit planing. A Head of Middle Years Program provided general curriculum leadership. Expectations about how teachers will work in the middle tier were otherwise unspecified. In this respect, Valley College had initiated a "superficial reform" (Aspland & Nicholson, 2003), where alterations in pedagogy and curriculum frameworks did not accompany a change in physical structure and organisation of the tier into two teaching groups.

This study was scheduled to run for a 10-week school term, with data collection sessions timed to coincide with particular phases of the school term. Term Three of the school year was seen as the most viable time for data collection due to the availability of time and teaching personnel, opportunities to observe more teaching lessons, and continuity of teaching time throughout the term. The Planning, Implementation and Reflection phases of data collection corresponded with the beginning (Weeks 1-2), middle (Weeks 3-8), and end (Weeks 9-10) of the term respectively. The teaching of a science unit in a third term (i.e., after general adjustments to practice were completed in Terms 1 and 2) was the immediate context within which to study group, team, and individual efforts to plan, teach, and evaluate a unit shared by four teachers.

Commonly, teachers have engaged in particular activities at different times through the term. For example, the planning phase of a unit often occurred at the beginning of the term, while the evaluation of the effectiveness of the unit typically occurred at the end of the unit. However, some planning continued during the implementation or teaching phase, and evaluation took place throughout the unit as teachers reflected on the effectiveness of different lessons.

Valley College was an independent Prep-Year 12 school, organised around programs specific to the pastoral care and curriculum needs of the students at particular developmental stages. For example, Years Prep to Year 3, 4-6, 7 8, 9-10, and 11-12 divided the age-grade tiers. The middle

tier program covered Years 7 and 8. A core group of primary- and secondary-trained teachers taught middle years classes in a combination of either Mathematics/Science or English/SOSE.

The middle tier program at Valley College commenced two years earlier in four demountable buildings comprising two classrooms each in a section of the grounds; it recently moved to a purpose-built block incorporating eight classrooms with adjoining computer rooms between each two classrooms. The science program adapted an existing junior science curriculum under the direction of the Senior School Science Head of Department (HOD). Mathematics was also directed by the Head of Mathematics Department and administered by the middle tier teachers. A Head of Middle Years (HOMY) appointed by the Head of School (HOS) directed English and SOSE. The Head of Science, Head of Middle Years Program, and Head of College were interviewed individually about their influence on middle schooling practices.

Participants

Primary teachers from current teaching staff and new graduate teachers formed the mathematics/science teaching group. Selection of participants for the study was based on three predetermined criteria: willingness to participate, teaching science fulltime in a middle setting, and previously taught or currently also teaching in a primary or secondary setting.

The two primary teachers were men who taught at this school for more than 10 years. Both taught Years 6 and 7 before the school reform and chose to teach middle tier science and mathematics. Both were Year 7 pastoral care teachers and collaborated with their English and SOSE teaching partners on pastoral care issues. These primary teachers worked together previously and were experienced in teaming, interdisciplinary teaching, and block scheduling, albeit from a primary years perspective.

The inexperienced secondary science teachers were young women employed in the middle tier program since the previous year. Both were secondary trained and, in addition to teaching middle tier science and mathematics, also taught secondary classes. Both were in their first full-time teaching positions, and each had less than 2 years teaching experience. These early-career teachers had no previous experience in teaming, interdisciplinary teaching, and block scheduling.

Both teachers were offered teaching positions by the school on the condition that they taught middle tier science and mathematics for a minimum of 2 years.

Preliminary findings

Initial inspection of raw data from this study indicates that the teachers encountered several challenges to initiating practices in planning a science unit. Moreover, school-based constraints on timetabling and curriculum and structure-based constraints on teachers' apparent willingness to gather on a regular basis affected their ability to work collaboratively. Group based collaboration among the four teachers as a professional learning community was minimal. In part, the top-down influence of the secondary school head of science department on planning the unit precluded active collaborative planning among the four teachers and helped to split the primary and secondary teachers into separate sub-teams. The loyalties of the graduate science teachers were given to the discipline-based values of the head of science, and they withdrew from efforts by the primary teaching to help them adopt an interdisciplinary approach. Team-based teaching devolved to a primary sub-team and a secondary sub-team, with different approaches. By the end of term, each teacher was evaluating their own teaching and making plans for the fourth term about how to help their students and improve their teaching. All showed professional concern for the students and for their own identities.

Conclusion

What it means to be a science teacher in an independent school middle milieu was being played out, unobserved, in classroom practices and everyday instructional activities. All teachers were actively engaged in teaching students about science, but they appeared to have different interpretations of what they were doing. The teachers were "dragging on the anchor" of collaborative teaching in different directions. Prior allegiances contributed to considerable tensions among primary and secondary teachers. In this school, individual teachers were not engaging in a change process with supports for the systematic introduction of middle schooling practices (Main, 2007, 2009). Although the middle tier was defined, occupied a building, and made structural allowance for teachers to engage in interdisciplinary team teaching, these teachers did not share a reform agenda, and prior identity was important in their everyday activities.

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Instructional dynamic figure

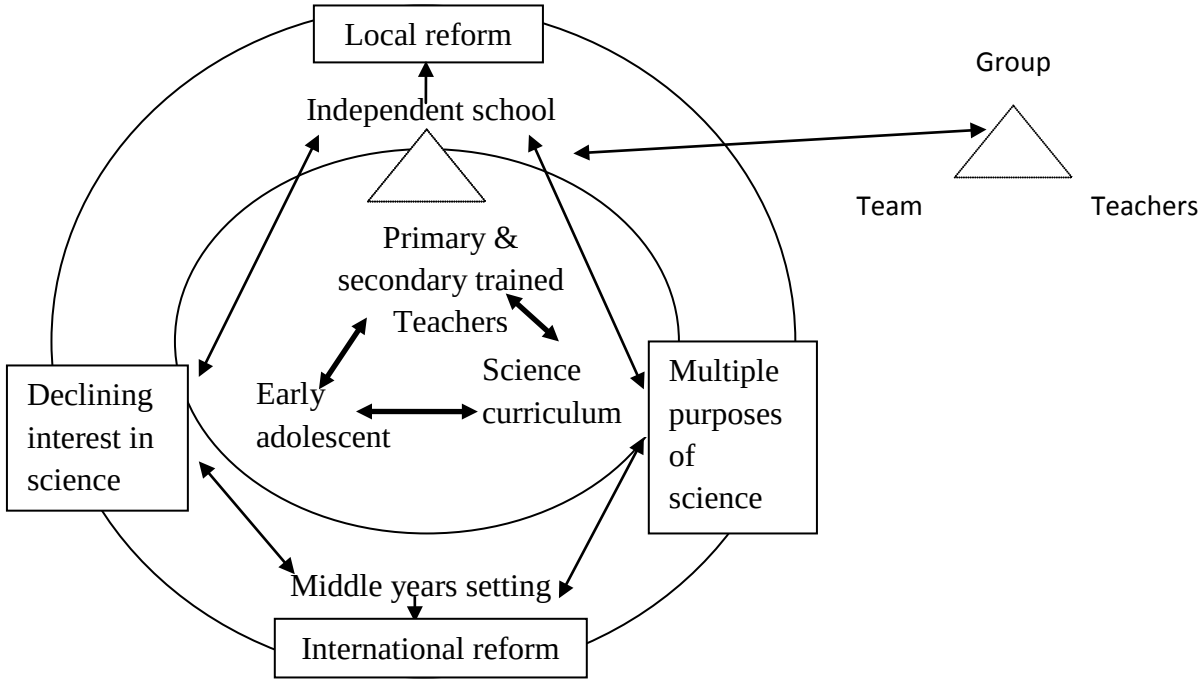

Figure 1. A model of the science teaching dynamic for a middle phase of school in an independent milieu. Adapted from Ball and Forzani (2007).

Table 1. Relationship of term teaching phases to Australian frameworks of reform and practice

Three-phase reform of practice (Pendergast et al., 2005)	Research-based criteria (Main & Bryer, 2007)	Term teaching phases
Time-flexible	Time-flexible	Time-fixed
Initiation: Initiation of teaching teams, curricula connected to real world, innovative leadership, and a focus on students' academic and social outcomes	**Acceptance:** Acceptance as teacher approval of middle years reforms (i.e., conscious decision to implement middle years practices and specific, acceptance of teaming when planning together).	**Planning:** Challenges to effective planning and challenges as barriers or facilitators to teaming practices, with the support of innovative leadership, and connectedness of student learning to the world outside the school
Development: Improved alignment of curriculum, pedagogy, and assessment systems; enhanced pedagogies, especially the provision of greater intellectual challenge; and establishment of professional learning communities with teachers as learners, with the support of strong, consistent leadership	**Effectiveness:** Specific indicators including implementation of teaming for planning and teaching, student-centred curriculum and students to autonomy as learners, and a safe environment in which all students experience success.	**Implementation:** Teachers' strategies to cope with challenges during teaching unit. Emphasis on teaming, connected curricula, and leadership support includes collaborative planning and teaching, alignment of curriculum, pedagogy and assessment systems, and enhanced pedagogies.
Consolidation: Serious focus on learning as a process, on learners and their needs, and on engaging students fully in learning; consolidating teaming as a viable planning and teaching practice.	**Sustainability:** Teacher satisfaction with the conditions of practice, particularly perceptions about support from the school community including administration; specific focus on sustaining teaming through evaluation and reflection into next unit cycle	**Reflection/Evaluation:** Self-reflection about unit in terms of acceptance and effectiveness of teaming practices and leadership support