CHAPTER 2

FLOATING AND SINKING: CONSTRUCTING THE 'GOOD SCIENCE TEACHER'.

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Abstract

Floating and sinking is a concept that both primary and secondary students are familiar with, however, this concept is often accompanied by misconceptions. A unit plan, consisting of seven lessons addressing the concept of floating and sinking, was developed by five High School teachers as part of on-going professional development to address common misconceptions. This paper analyses reflections of the teachers and reads these reflections against dominant discourses contained within various Education Queensland policy documents that construct the 'good science teacher'. In the discourse analysis of the teachers' evaluations of, and reflections on, this unit plan, two significant outcomes resulted; firstly the development of this unit plan was instrumental in enhancing individual pedagogical content knowledge and secondly, the process of developing the unit plan worked as a team and partnership building exercise. The chapter concluded that the teachers were enthusiastic towards the 'hands on' practical sessions and embraced working scientifically, but were sometimes constrained by the need to accommodate other school activities and expectations as they performed as 'good science teachers'.

INTRODUCTION

This chapter explores the notion of the 'good science teacher' through the reflections of five teachers, Wendy, Christine, Geoff, Gordon and Susan who participated in a professional development workshop that involved developing and implementing a unit plan concerned with floating and sinking with their Year 9 classes. The 'good science teacher' is a discursive construction that can be found in various educational policy documents that shape the High School workplace. This construction is reflected in the narratives of the five teachers as they talk about their workplace and the development of the floating and sinking unit plan. The unit plan, consisting of seven lessons, was developed to address common misconceptions in science. These seven lessons were designed to build a

sequential and conceptual understanding of floating and sinking as the interaction of balanced and unbalanced forces.

This chapter is divided into three main sections. The first section deals with the contextual dimension outlining a 'crisis' in science teaching where I summarise the current emphasis on professional development. In the second section I discuss the theoretical framing of 'performativity' that can be used to explain the construction and performance of the 'good science teacher' and define the concept of discourse. The third section presents the voices of the teachers as they reflect on the process of developing and implementing the unit plan and this is read against particular dominant discourses embedded within various policy documents. From a discourse analysis of the teachers' narratives two significant outcomes emerged: the enhancement of personal PCK and the resultant team building exercise among the participants. I draw attention to the enthusiasm of the teachers towards the 'hands on' practical sessions, but suggest that performances of 'good science teachers' are sometimes constrained by the need to accommodate other workplace expectations. I now turn to what some people call the crisis in science teaching.

CRISIS IN SCIENCE TEACHING

In 2000 Goodrum, Hackling and Rennie (2000) undertook a study into the status and quality of teaching and learning of science in Australian schools. This study showed the following major concerns:

- The actual curriculum implemented in most schools was different from the intended curriculum; in some primary schools science was not taught at all, in many high schools, the science taught was often perceived as irrelevant and uninteresting, subsequently reflected in declining numbers of students enrolling in senior science subjects.

- Many science teachers felt undervalued, under-resourced and overloaded with non-teaching duties as they attempt to respond to changing societal expectations and community needs.

- University science teacher education is under-resourced and close to crisis with faculty staffing much smaller than ten years ago and

- The aging profile of school science teachers and their anticipated retirement also presents a major concern for the public education system (Goodrum et al., 2000, p. viii).

Coinciding with these concerns has been the implementation of a new science curriculum in Queensland (Queensland Schools Curriculum Council, (QSCC), 1999). The science curriculum is one of a series of new curricula introduced over the past 3-4 years where '*learning for understanding*' is a key aim. These documents are based on a constructivist theory of learning, highlighting the nature of learning and

knowledge as socially constructed. The new science curriculum specifically aims to develop students' conceptual understandings in science, replacing the content focus of previous curricula; the new curriculum is outcomes-based and emphasises a 'working scientifically' approach where this approach focuses on 'investigating, understanding and communicating' (QSCC,1999, p. 32).

Subsequent to the major report by Goodrum et al., (2000) there was a review of teaching and teacher education (Committee for the Review of Teaching and Teaching Education, (CRTTE), 2002). A conclusion reached here was that "a fundamental role of school science education was to develop and improve the scientific literacy of students" and thus a "priority [was] to consolidate and improve the quality of school science" (CRTTE, 2002, p. 5). This indicates a dominant discourse signalling the need to improve science teaching and to attract more talented people into science teaching. Unfortunately this kind of discourse implicitly constructs current science teachers as lacking talent or skills to effectively teach school science. At the same time this discourse sends implicit messages to these High School science teachers that what they are doing is irrelevant and does not engage students effectively. Goodrum et al. (2000) highlighted these issues as contributing to the declining enrolments in senior science subjects indicating that students are dissatisfied with their science experiences at High School.

While this discourse emphasises the need for change, it can also be read as devaluing the very good work being done by many current High School teachers and clearly signals the need to support those 'good science teachers' who are working within a system impacted by multiple pressures. These pressures include (among others) expectations of parents, employers, the school workplace, policy documents and political agendas. One form of support that many teachers find valuable is professional development.

PROFESSIONAL DEVELOPMENT

The high priority placed on science education by the Queensland Government can be seen by the development and implementation of the new science syllabus in 1999. Introducing a new syllabus initiated a change from explicit content knowledge to an emphasis on the process of 'doing' science. This meant that science teachers were required to develop proficiency with these new directions. According to Luke (2002) the requirement for professional development falls neatly into the Federal government's overall strategy associated with market driven consumerism in that:

> Current strategies of marketisation are contingent upon a 'crisis' requiring a curiously parasitic mix of direct government intervention (often highly regulatory and

> centrally directive, despite supposed neo-liberal opposition to
> regulatory regimes) that often spurs the desire and demand for
> new pedagogic products (Luke, 2002, p. 200).

In other words by establishing a 'crisis' around the quality and quantity of science teaching, the Federal government can effectively create a market for the provision of professional development. At the Queensland State level there is a dominant discourse that promotes Queensland as the 'Smart State' where teachers are encouraged to reflect on their pedagogical practices and participate in professional development to address the range of new syllabus documents introduced to state schools over the past 4-5 years. In the Education Queensland policy document *"2010: A future strategy"* teachers are encouraged to identify their professional requirements and seek out relevant professional development. As part of addressing professional development regarding the new Queensland Science syllabus (Queensland Schools Curriculum Council, 1999) a partnership between the Faculty of Education and Creative Arts, CQU, and BHS, a rural High School located some distance from the university, was formed where five science teachers "identified their skill development needs" (Education Queensland, 2001, p. 31). This resulted in the development of a unit plan focussing on floating and sinking.

DEVELOPING A UNIT OF WORK: FLOATING AND SINKING

The aim of this unit plan was to develop a conceptual understanding of floating and sinking as balanced and unbalanced forces through a step-by-step or sequenced construction of knowledge articulated by a series of 'hands on' activities. This unit plan involved seven lessons that were designed to construct knowledge of forces as a consecutive process building from lesson 1 through 7. Lesson 1 began with a 'Predict, Observe, Explain' activity where students were presented with a problem — what things float, what things sink and what are we unsure of — where students' prior knowledge was explored. In Lesson 7 the students constructed individual Cartesian Divers as the practical component of their assessment where students' were required to demonstrate their understandings of balanced forces that they had developed during the intervening lessons. The lessons took place over a period of 3-4 weeks. Developing this unit plan was the main reason for these particular teachers to come together. I was interested in how their reflections on the unit plan corresponded with their personal image of the 'good science teacher'. To investigate this I looked at discourses embedded within their interview data and compared/read these discourses against dominant discourses contained with specific policy documents.

This chapter is based on the findings of the discourse analysis of interviews done with the teachers, who were asked to reflect on the lessons, after they had implemented the floating and sinking unit plan. Discourses, such as institutional discourses for example, can be defined as particular ways of

speaking that reflect the values and beliefs of that institution. Smith (1987, p. 214) suggests that institutional discourses create relations among subjects, appearing as a body of knowledge in its own right, with these forms of discourse accomplished through socially organised practices. Weedon (1987, p. 108) argues that discourses are more than just ways of thinking and meaning making, rather they constitute the 'nature' of the body, unconsciousness and consciousness mind and emotional life of the subjects that they seek to govern. In other words discourse is about knowledge production, social practices and power relations. From the teachers' narratives, then, particular discourses revealed certain 'performances' around what it meant to be a teacher in this site at this time. These 'performances' could also be read against dominant discourses embedded in various Queensland State educational policy documents. Therefore the interview data was analysed using the concept of performativity (Butler, 1990).

'PERFORMATIVITY': A WAY OF EXPLAINING TEACHERS' PERFORMANCES

When looking at how teachers do their work and interact with the workplace, Butler's (1990) concept of 'performativity' is useful. According to Butler (1990) bodies are inscribed with their identities through discourse; in other words bodies are discursively constructed from signs such as sex, gender, race, age, ethnicity and /or class, bringing with them specific cultural messages; these messages either reinforce or challenge constructed stereotypes. This means that particular values and beliefs, associated with specific bodies that reflect the dominant cultural group in society, are reinforced and reproduced. Conforming to norms, values, beliefs and expectations are part of the normalising effect of dominant discourses.

Butler (1990) suggests that identities are inscribed through repetitive acts or performances that signify these same identities. Therefore discourses and practices associated with the teacher produce the precise norms and expectations about what it means to be a teacher in a specific site or social structure that are subsequently acted out in these contexts. For example, dominant discourses associated with the 'teacher' comprise the nurturer, expert knowledge, pedagogical competence, and disciplinarian, to name a few, and it is through performing as a nurturer or a person transmitting expert knowledge or the kind of discipline applied, that tells others — this person is a teacher. Consequently through the performance of specific practices and expectations that are recognised as norms and values around teaching, people can construct their image of a 'good' or 'bad' teacher. Similarly within specific texts, such as policy documents and formal reports, dominant discourses that construct the 'good [science] teacher' can be detected. Therefore the construction of a 'good science teacher' emerges from the ways in which specific teachers act and the kinds of practices they

employ in their workplace and also from the ways in which science teachers, or any other teachers, are talked about within formal policy documents. Reading these discourses against performances the 'reader' is able to determine whether the performer can be seen as conforming to an image of the ideal or 'good science teacher' or not.

THE CONSTRUCTION OF THE 'GOOD SCIENCE TEACHER'

In this section I present a reading of the 'good science teacher' that can be discerned from discourses within various educational policy documents that influence the state school workplace in Queensland. A 'good science teacher' is a discursive construction or body who has the ability to appropriately transmit content knowledge into a form from which students can learn (Appleton & Asoko, 1996; Education Queensland, 2001). Specific content knowledge is able to transformed by the teacher, via their own personal PCK, using a pedagogical approach whereby meaningful knowledge is taught appropriately to facilitate students' understandings. This [teacher] body negotiates "identifying and overcoming barriers that limit students' participation in and benefits from schooling" (QCSS, 1999, p. 6). The 'good science teacher' guides and facilitates learning developing "critical and creative thinking, problem solving and decision-making skills" in students (QSCC, 1999, p. 7). Coupled with this is the development of 'lifeskills' where the teacher provides "opportunities for students to develop communication skills, interpersonal skills and ethical and cultural sensitivities and understandings" (QSCC, 1999, p. 5).

Teachers are asked to continually reflect on their practices as "this will help them to identify their own skill development needs and plan appropriate learning and development" (Education Queensland, 2001, p. 31). The code of ethics for Queensland teachers (Board of Teacher Registration, (BTR), 2003, p. 3) explicitly states that teachers should participate in professional development and teach according to each students' educational ability and potential. As well teachers need to accept personal responsibility for providing quality teaching while seeking available support and resources to improve teaching practice (BTR, 2003, p. 3). Implicitly embedded in this discourse is the notion that teachers will never reach the point of best practice, because of the continual need to improve teaching practice. The professional standards that guide teachers' work:

> represent the skills and knowledges teachers need to create relevant and worthwhile learning experiences for individuals and groups of students... applying these standards will enable teachers to structure flexible and innovative learning experiences (Education Queensland, 2001, p. 3).

While these standards may be perceived as guidelines, the discourses embedded within these documents implicitly transmit the message that if the teacher does not perform adequately to meet these standards then that

teacher is not fulfilling the image of the 'good teacher' or indeed the 'good science teacher'. The 'good science teacher' has the following demands placed on them which impact on how they 'do' their work. The 'good science teacher' is continually enlarging his/her PCK, is required to have interesting and engaging lessons, must motivate students to learn and have good behavioural management skills. I argue in the following sections that the five teachers at BHS are 'good science teachers' when read against these documents. However they are also positioned within a constructed political context that places institutional constraints in the way of teachers work.

One of these institutional constraints is the availability of specifically trained teachers as Christine, the Head of the Science Department, explains:

> Graham is trained as a Primary [teacher] and Wendy is trained as a science teacher but has been working in the library for a long time and has only just come back to science. Some of them are teaching out of their teaching area ... we don't have a biology teacher this year so Wendy is teaching it.

Many regional high schools have difficulty in employing secondary science teachers because there simply are not enough appropriately trained people. This means that some classes are taught by 'outfielders' (Bulman & Harrison, 2003) or those teachers who are specialists in subjects other than in what they are actually teaching. Another influence present within regional High Schools is the mix of experience. Christine feels that her department is very fortunate because:

> I think the depth of knowledge in the Science Department is quite good. There are some that have had some teaching experience in other places and then have come here and others have done their first year here and have stayed; it's a mixture, a good mix I think, because you have got experience and youth.

Christine feels that this mixture of youth and experience brings a certain quality to her department where each of the teachers can gain from the environment. At BHS the science teachers are encouraged to participate in continual professional development activities. These activities concentrate on PCK (Appleton, 2003) and are designed to get teachers away from using textbooks as lessons (Zipf & Harrison, 2002). For Christine this adds richness to the overall culture of the workplace and enables her teachers to grow professionally and to negotiate other institutional constraints. These constraints include the time available to fit in all of the expectations of parents and other stakeholders, working through overcrowded curricula, lack of adequate resources, the endless meetings, and the participation in non-teaching duties — a rapidly expanding area. These kinds of discourses

create the contexts that influence and shape what teachers 'do' and this is coupled with the workplace culture of the specific site.

SHAPING PERFORMANCES: DISCURSIVE CONSTRUCTIONS OF SCIENCE TEACHERS

In this section I present reflections of the teachers and illustrate the way in which powerful discourses shape the subsequent performances of these teachers as they talked about the process of developing and implementing their unit plan. There were two significant outcomes for the teachers when they reflected on the professional development workshop. The first outcome concerned the development of personal PCK and the second outcome related to the process of team building as they participated in the workshop and subsequent implementation of their unit plan. In the next sub-section I explore how enhancement of their personal PCK can be read as these teachers performing as the 'good science teacher'.

PERFORMING AS THE 'GOOD SCIENCE TEACHER': DEVELOPING PCK

In this sub-section I draw on the stories shared by Graham who, as part of his evaluation, commented that during the implementation of the unit he had:

> [I've] picked up some new skills, I've seen how to have the enquiry sort of approach and a heavily activity based approach works quite well. I've learnt to manage those activities as it becomes very busy; to organise the pracs, make sure the lesson keeps flowing form one to another. Yes, it's certainly been a learning experience for myself.

In this narrative Graham is constructing his performance in parallel to dominant discourses around the 'good science teacher' with this seen in the implementation of an enquiry approach, good class management or control over the activities in the 'pracs' and with making links between lessons. Goodrum et al., (2000, p. viii) indicate that traditional 'chalk and talk' lectures and 'cookbook' practical lessons do not challenge or engage high school students in science. Graham went on to say "I think the kids do enjoy science no matter what happens, but this one they particularly enjoyed more, more than most'. With this comment it can be seen that Graham does not perceive his students as disengaged with science, rather he sees science as something that the students do enjoy. In this way Graham is able to construct his teaching as relevant, enjoyable in a carefully controlled classroom context, allowing him to identify his performance as that of a 'good science teacher'. Similarly Susan felt very positive about the unit plan as indicated in her comments:

> Yes, it [unit plan] was pretty good; I think the kids really enjoyed doing something a bit different, for a change because we have just finished doing lots of chemistry and writing,

> lots of equations so it was a good change for them ... they
> like doing lots of hands on things. I liked how they predicted
> every activity and that they had to have a reason for that
> prediction, so they couldn't just say 'oh this will float
> because it just will' and ... that they had thinking time after
> the experiments.

Susan saw the 'hands on' practical focus as a way of showing students that there are multiple ways of 'doing science'. She inferred that students are not always enthused by chemical equations however in this unit the students were expected to engage in higher order thinking and create explanations for what they saw happening in the activities. Susan can also be seen as constructing her identity as a 'good science teacher' through the use of constructivist approaches to science and in the way that she negotiated 'need to know' information:

> You weren't actually giving them the content knowledge,
> they had to come up with that themselves which I found was
> good with the kids that could get it, but the ones that
> couldn't, I think they fell a bit behind ... maybe after each
> experiment, like after we talk about it I actually gave them
> [those falling behind] the knowledge that they needed to
> know to go onto the next one [activity].

While Susan liked the constructivist approach she expressed concern over those students who may fall behind for various reasons — missing a lesson, not understanding the specific activity — and in constructing her identity as the 'good science teacher' she felt it important to give more content knowledge to some students rather than let them fall behind. This was an issue that she discussed with her colleagues. In the following sub-section I present the second outcome that highlighted the team building that resulted from the planning, implementing and then reflecting, as a group, on the success of the unit plan.

PERFORMING POLICY: TEAM BUILDING THROUGH COLLABORATIVE PLANNING AND TEACHING

In this sub-section I focus on how these teachers found the process of developing their unit plan as a way of enhancing their team building skills and how this process brought them together in a collegial way that enabled them to talk about the content of the unit and to discuss their individual concerns related to implementing this unit. Previously I noted that Graham considered the process of creating the unit plan had facilitated discussion among the group that focused on learning from each other. Similarly, Geoff found talking among colleagues was good as he shows in the following excerpt:

> We're all busy so, normally, one person gets delegated to do
> a unit and distribute it out and you might ask some queries
> about the assessment, or new activities. But with this
> [development of the unit] we were engaged in this extensive
> dialogue. Because it wasn't content based, to be able to put
> it [the unit] together, people had to develop their own
> explanations so that was a lot of talking. I call that extensive
> dialogue because it was a bunch of professionals trying to get
> a grip of things that hadn't been documented in a traditional
> way, it was a slightly newer approach to it — we talked all
> the time.

Geoff draws attention to the way in which the science teachers would
usually work as a team in order to 'fit in' all the demands on them in a
working day. With the new unit, because of the different approach and focus
on 'hands on' science, different preparation was required. It is interesting to
note that Geoff saw the focus on 'hands on' activities as not content based.
In other words content here appeared to mean using a textbook. This
different preparation of a unit plan shaped the performances of the teachers
— they needed to talk to each other about content rather than simply
regurgitating the traditional textbook version (Zipf & Harrison, 2002).
Geoff sees this as part of the new direction of public education policy, as
indicated in these comments:

> I think it's crucial, [that teachers talk and work
> collaboratively] particularly with the way the direction in
> which education, or education in Qld, has been outlined to
> us ... has been identified to us as one of the failings of not
> necessarily the system, it's just that the teachers don't have
> that support network and I think to be professional you need
> to discuss, openly discuss, what are the shortcomings or
> your strengths so that they can be out in the open and we can
> all move together so that even though we all have different
> classes I think that we all talk the similar sort of thing.

Geoff considers this lack of professional conversations more as a personal
failing, that is "not necessarily a failing of the system", however I would
argue that current practices that result in teachers being under-resourced and
overloaded is clearly a failure of the system, not of the individual teacher.
Clearly the policy discourse states one thing, but in practice, this is not
addressed within local sites because of institutional constraints, such as
overloaded timetables, overloaded curricula and the need to accommodate
special school functions such as sports days and community activities.

I argue, therefore, that this would ultimately influence the way in which
Geoff constructs his own identity as the 'good science teacher'. He refers to
the direction of Education Queensland and the need for teachers to "talk and

work collaboratively". By not doing this Geoff could perceive himself as performing as a 'bad teacher' rather than a 'good science teacher'. Alternatively, this could influence his decision to actively "engage in extensive dialogue" around the implementation of the unit plan. Gordon was quite enthusiastic about the social interaction that the unit plan had facilitated:

> The teachers had to interact with each other to get information and feedback to each other and that's a hard thing to accomplish and that [activity] gave us a 'togetherness' as a whole. The overall activity itself had everyone tied up together, there was lots of interaction going on, that was one aspect I really appreciated, besides the outcomes we achieved.

Gordon really enjoyed his involvement as part of the group. There had been time set aside to do this development work and for Gordon it was a luxury to talk with his colleagues, as ordinarily time constraints and other workplace expectations meant that they did not always get to meet as a team of science teachers. Wendy highlights her perceptions of institutional constraints that curb team discussions and inhibit the ideal scenario of networking that teachers are encouraged to foster (Education Queensland, 2002). Wendy is commenting on the enjoyment she got from talking with her colleagues about the new unit plan:

> Yes I did enjoy the discussions with the other teachers, when we were discussing the experiments before we did them and helping each other with what went well and what didn't go well and what to look out for and it was also rushed with it, it was enjoyable but frustrating because you never got to finish anything but that's par for the course.

Wendy draws attention to the lack of time she feels that the team have to implement some of the networking and team building partnerships that are promoted in documents such as the '2010' future strategy policy where it is explicitly understood that "providing time for teachers to participate is critical" (Education Queensland, 2002, p. 21). Obviously illustrated here is the tension between the reality of the workplace and the ideal of the policy. Wendy has drawn attention to the negotiations that take place as teachers plan their units of work. It can be argued, then, that coupled with the other pressures placed on their performance as teachers, Geoff, Graham and Wendy are required to continually aspire to perfection in light of severe constraints with the possibility of severe burnout and resignation from the public education system being an outcome in a 'worst' case scenario.

Each of the teachers responded and negotiated dominant discourses articulating within their workplaces in different ways. I argue that the degree to which they reconcile and redefine their personal constructions of the

'good science teacher' is therefore influenced by the institutional expectations, their personal expectations and interpretations of key policy documents. What this clearly highlights are the multiple subjectivities brought into the school-based workplace — an arena of competing and contesting representations and discourses around the 'good [science] teacher'. These teachers can be seen as 'good science teachers' through their desire and actions to increase their personal PCK (Appleton & Asoko, 1996; Education Queensland, 2001). Their involvement with developing the unit plan enabled these teachers to also "identify their own skill development needs and plan appropriate learning" (Education Queensland, 2001, p. 31). While Wendy felt there were institutional constraints that inhibited the group getting together, it became clear that by the end of the process of this development and implementation of the floating and sinking unit plan had been able to facilitate a team building exercise that enabled the group to move from being a collection of teachers together in a specific site — the science department at BHS — to become the science team that enthusiastically worked together towards a common goal centred around their unit of work.

CONCLUSION

In this chapter I have explored the discursive construction of the 'good science teacher' that can be read within policy documents that shape the school workplace. Discourses around the 'good science teacher' construct a body that participates in professional development, seeks to continually improve their teaching and students' learning and works in partnerships — be that between the teacher and student, teacher and colleagues or teacher and the community. Maintaining the representation of this 'good science teacher' demands specific performances that demonstrate the underlying ideological discourses and policies of both the Queensland and Federal governments. The overt pressure to 'do' professional development can be seen as a consequence of particular discourses and government ideologies. Overall, the five teachers were satisfied with the unit of work because it fell neatly into the design and direction of the new science curriculum. BHS forms a site where the contesting and competing discourses influence and shape the performances of teachers as they negotiate the dominant discourses circulating their workplaces. Two significant outcomes for these teachers were the enhancement of personal PCK and the resultant team building as they talked through their concerns and excitement with facilitating a new unit of work.

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