

# Routes into student engagement as part of the pedagogical reasoning of teachers

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## Abstract

This paper reports on a large study investigating the pedagogical reasoning of 40 expert science teachers in Australia in an attempt to explicate expert practice. Over a three-year period, the teachers were divided into two cohorts involving both elementary and high school teachers of science. Each cohort experienced eight days of a professional program that helped to focus their attention and unpack the complex and detailed tacit knowledge about teaching ‘carried in their heads’. The main sources of data were the recorded planning conversations of teachers as they worked with peers in designing, preparing and developing a unit of work for their students along with interviews that were conducted with all 40 teachers involved in the project. Additional data was extracted from notes, summaries and conversations captured during the days of the professional program. Coding of these data identified major themes that were compared to those from an earlier pilot study. Emerging from a comparison of these analyses were four key foci, which form a framework for elucidating the tacit pedagogical reasoning of teachers. These included: *Big ideas*, *Generation of quality learning and quality learners*, *Responding to contextual constraints and opportunities*, *Teacher personal and professional identify*, and *Routes to engagement*. Careful mapping of teacher thinking (as evidenced from their conversations) between these foci demonstrated rapid and complex movement from one focus to the other as teachers planned their teaching. We termed this ‘pinball reasoning’. Within this paper we report on the findings in relation to latter focus, *Routes to engagement* using the phenomena of pinball reasoning to discuss the multiple ways teachers could be led to thinking about engagement.

**Keywords:** pedagogical reasoning; student engagement; learning, pinball reasoning

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## Introduction

Pedagogical reasoning as defined by Lee Shulman (1987, p. 15) is “*the process of [teachers] transforming subject matter knowledge into forms that are pedagogically powerful*”. As such it refers to the thinking and planning undertaken by teachers as they design and teach their lessons placing the emphasis clearly on the “intellectual basis for teaching” rather than just the behavioural outcomes (p. 20). The term pedagogical reasoning was first used by Shulman to conceptualise the rather sophisticated and tacit knowledge about teaching that expert teachers carry ‘in their heads’. His work deliberately set out to counteract the teacher effectiveness research at the time that presented teaching in a sterile and reductionist manner that often overlooked the deeply complex and sophisticated knowledge that expert teachers bring to their interactions with their students around learning.

In his work, Shulman (1987) found that teachers worked through the following six activities when planning their teaching.

- **Comprehension:** Teachers develop an understanding of the set of ideas to be taught along with how one idea relates to other ideas in the subject area but also with other subject areas. Additionally, this includes teachers having a clear understanding of the educational purposes of the activity, such as student literacy, the opportunity to inquire and question while developing values for a “just society” (p. 14).
- **Transformation:** Teachers’ understandings of the subject matter are transformed into ways of knowing for the learners. This process requires moving from the personal comprehension of the teacher to focus on the comprehension of others with planning and thinking associated with the best ways to support learning.
- **Instruction:** Enactment of the teaching and pedagogies including questioning, checking student work and ideas, organization of the learning environment while also building relationships with students.
- **Evaluation:** Checking for understanding of the learner that requires teachers to understand not only the material and skills but also the processes of learning.
- **Reflection:** Teachers look back over their teaching to consider what has been learned, whether the experiences were supportive of student learning, and the student emotions positive.
- **New comprehensions:** The teaching experience provides new insights and comprehensions that further impact the next teaching experience resulting in a new beginning.

As articulated here, Shulman conceptualized this sequence as being cyclical, beginning and ending with comprehension. While this appears quite reasonable and there was some evidence for it at the time, it was still an essentially linear process.

Over the last three years, a large study involving 40 expert teachers of science in Australia has attempted to build on this work of Shulman by exploring the ways in which expert teachers turn scientific content and curriculum expectations into something that is ‘pedagogically powerful’. Empirical studies of teacher’s actual pedagogical reasoning are rare while studies of teachers who can be argued to be expert are even harder to find. An earlier pilot study by members of the research team with the same 10 teachers over a period of five years identified that the pedagogical reasoning of teachers appeared to involve a very non-linear interplay between four key focal concepts: *Big ideas*, *Routes to engagement*, *Generation of quality learning and quality learners*, and *Responding to contextual constraints and opportunities* (Keast, Mitchell, Panizzon, Loughran, & Tham, 2015).

The larger study discussed in this paper built upon the findings of the earlier pilot, with this particular paper focusing only on one of these focal concepts in detail – *Routes into student engagement*.

## Routes to Student Engagement

Engagement is a complex and ‘messy’ (Harris, 2011) meta-construct (Fredricks, Blumenfeld, & Paris, 2004). It is often categorised into behavioural, psychological (or affective), and cognitive dimensions. However, two additional dimensions have been recently proposed: meta-cognitive as students focus on their own learning; (Mitchell & Carbone, 2011) and, agentic whereby students are encouraged to contribute to the flow of teaching (Reeve & Tseng, 2011). These different dimensions of engagement, while not necessarily in conflict, do reflect different teaching purposes. Ask any experienced teacher and they will automatically identify the importance of student engagement as one way of gauging a successful lesson. However, the actual need for engaging students is not so clearly articulated in the research literature. Part of the issue here is that it depends upon which aspects of engagement are being pursued. For example, research that focuses on behavioural, psychological and cognitive engagement seem to monitor key outcomes, such as improving student connectivity to school, creating positive affective behaviours, improving academic results, and lowering drop-out rates (Fredricks et al., 2004; van Uden, Ritzen, & Pieters, 2013). In general, the purpose of behavioural and affective engagement tends to be about creating a happy and peaceful classroom climate where students comply with the teacher’s instructions while the purposes of cognitive and metacognitive engagement are around the quality of student learning.

A review of the literature identifies minimal research around teachers’ perspectives of student engagement with available studies utilising extremely small samples of teachers thereby limiting the generalizability of these results (Harris, 2011).

Furthermore, a number of these studies report a deficit discourse by teachers about a lack of student engagement with their core purpose around the compliance of students during lessons.

'Routes' into engagement refer specifically to the tasks or strategies used by teachers to encourage student participation in learning and it is this aspect that prevails in the literature. In particular the ideas most often cited include "embedded collaboration, integrated technology, inquiry-based learning,

assessment for learning, and making learning interdisciplinary and relevant to real life" (Taylor & Parsons, 2011, p. 25). While these are a beginning, our focus was to explore more fully the possible routes into engagement used by expert teachers to enhance student learning in science and then how these connected to their broader pedagogical reasoning.

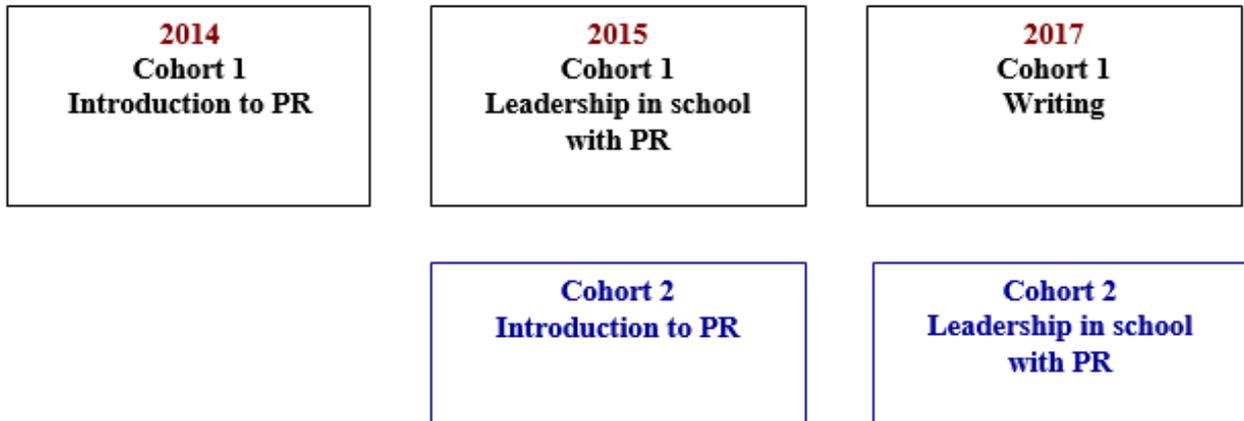


Figure 1. Research design – cohorts and focus of project

Data were collected in a number of ways throughout the project. Firstly, each teacher involved in the project was given a digital voice recorder to record their conversations while planning lessons with peers and when designing and preparing each teaching event. These data were uploaded to allocated folders (using Dropbox) with individualised teacher access and listened to by the authors, transcribed, coded and mapped. Secondly, school visits were conducted between professional development days by a research assistant who interviewed all the teachers involved in the project to collect more detailed information regarding the growth of the pedagogical reasoning. Thirdly, data were collected from each of the professional development days as teachers worked through various activities and were required to report back to the group. Finally, time was given near the end of the projects for teachers to write vignettes from their classrooms.

Findings from the analyses of these different data sources supported the four key foci that were identified in the earlier pilot study that formed the foundation for the larger study reported here. As mentioned above, these foci included: Big ideas, Routes to engagement, Generation of quality learning and quality learners, and Responding to contextual constraints and opportunities. A new focus emerged from the teachers in this larger study, which was termed *Teacher personal and professional identity*.

We return to these other foci later in the paper, however, the aim of this paper is to address the

research question: *How did these expert teachers of science plan for student engagement in their teaching?* It should be noted that this is achieved by discussing the findings as they relate to how teachers **planned** for student engagement and **not** on what engagement actually looked like in their classrooms. Hence, there was no need to undertake lesson observations as part of the research design.

## Results and Discussion

The data were rich in terms of the number of coded comments from teachers aligned to student engagement. It was noted that the teachers seemed to be very sensitive to, and confident about what was either likely or unlikely to engage their students with science. Interestingly, we identified no deficit discourse in the way teachers discussed engagement, nor was there a strong focus on behavioural engagement except when they considered factors, such as students getting tired. The teacher discourse was around (and coded for) affective, cognitive and more rarely, metacognitive engagement that was driven by the teachers' intentions to promote different aspects of quality learning. However, we stress that many routes to engagement have elements of more than one of these dimensions. For example, for many students (but not all) a route to engagement was via group work and collaborative tasks. However, this had affective elements (many students like working in groups), but also metacognitive elements with teachers planning to include reflection of and discussion about effective group behaviours.

There were many comments that were coded as routes to affective engagement with many of these identifying several ways of generating *perceived relevance*. Some of these included using actual local artefacts, connecting to societal experiences (sometimes in ways that deliberately challenged students' values), or connecting to personal experiences including ones that had an emotional dimension. A memorable example of the latter was as teachers planned a unit around 'Place' during which they asked students how they might feel if they were ignored and did not have a Place. Other teachers used popular media to frame intriguing questions. For example, the government road safety authority in Australia funds dramatic television advertisements about road safety. This resource stimulated a pair of teachers to ask: *What is the science used to make a car safe?* This stimulated students to investigate how air bags (only one example) slow the rate of deceleration during a crash and (by Newton's second law) reduce the force on the car occupants as they decelerate.

*Variety* was another route to affective engagement that could involve activities with intrinsic interest, such as creatively using ICTs to present learning. Sometimes they used a dramatic experience although the teachers were quite cautious about the extent to which these could be used to sustain engagement over the longer term. As one group of teachers wrote during a full day professional development day, "*activities that are too stimulating can be counterproductive for affective engagement – if they have their minds blown then they may become too distracted to engage in quality learning*". Teachers recognized that 'whizz bang' experiments were often memorable for students but they were considered only as an entry point into quality learning. It was noted that affective engagement was often referred to by teachers as emotional engagement, which was perceived as being important because in showing their own emotions (i.e., interest and excitement) to the students it was likely to generate similar emotions in their students. As quoted by one teacher: "*If teachers are excited then the students will also be excited!*"

Critically, the strongest theme in the data was for cognitive engagement as the teachers used thinking about quality learning and deep processing as a route to cognitively engage their students. The majority of teachers considered that this would in most instances normally eliminate problems around behavioural engagement. Strategies articulated by teachers included:

(i) Scaffolding ways that students could discover or work out part of the content for themselves. For example, a teacher was about to teach students that the angle of incidence equals the angle of reflection as part of a unit on light. She wrote:

*Looking around the room I noticed that the join lines in the lino met the kickboards of the cupboards at 90°. So I explained the concept of the join in the lino*

*being the "normal" and then gave them a ball. I asked them to roll it to the junction of the join and the kickboard at various angles and asked them to make observations about the angle at which the ball bounced back off the wall. As they were doing this, the other students got intrigued and wanted to join in as soon as they finished their questions. By now, some students had finished their ball activity so I asked them to work out the "law". By the end of the class every group had learnt that the angle of incidence = the angle of reflection without any help from me.*

(ii) Practical investigations where students had a genuine question to answer (i.e., not just demonstrating or 'proving' some known piece of science). An example of this was when a Grade 5 class looking after a kitchen garden had to solve a real and unplanned problem related to why the teacher's plants had survived and why the students had not.

(iii) Requiring students to process and rework information that could not be completed by simply cutting and pasting, such as constructing a role-play of the motion demonstrated in a distance-time graph.

(iv) Ensuring that students had opportunities to apply their learning in several different contexts.

(v) A recurring theme in the approaches shared by teachers to promote cognitive engagement was to build a sense of shared intellectual control (Mitchell, 2010). One way of doing this was to give students different sorts of choices and opportunities for decision-making. For example, a senior Biology teacher decided to give students choice and flexibility about the pace and order of tasks. She wrote:

*Cells, organelles and microscopes ...it is a boring topic and if I'm bored, then they'll be bored. It is required knowledge for Year 12 Biology so we couldn't remove it from the course, so what to do? I decided to deliver the material as a self-paced unit. Students were given a 'kit' with all of the instructions [equipment] and worksheets that they would need for the unit. The self-paced style of the unit gave the students some ownership of the work. They could choose in what order they covered the content, whether they wanted to work individually or in groups and at what pace.*

Another common way of sharing intellectual control was to promote and use students' questions. Many elementary teachers would give their students some shared experiences in a new topic and then set up a 'wonder wall' of student questions that drove the rest of the unit. For example, a wonder wall question on the water cycle (from a class that had studied gravity) was: *Why does steam go up?* This opened up several issues in the discussion that positioned students as intellectual partners in the classroom discourse.

This idea aligns very closely to what Reeve and Tseng (2011) proposed and labelled as agentic engagement. While this type of engagement lies in a different dimension to behavioural, emotional and cognitive engagement it is often linked to them. While this view resonates strongly with our construct of shared intellectual control, the (Taiwanese) classrooms described by Reeve and Tseng may have been more teacher-centred than those of the teachers comprising our study.

To achieve quality learning you need quality learners and there were examples of teachers setting out to promote what Mitchell and Carbone (2010) defined as metacognitive engagement – where students were engaged in purposeful reflection about how they had been or could enhance their own learning. This included reflection on how they could ask “good” questions –ones that were helpful to classroom learning. A number of the teachers in the study shared well-articulated agendas about how metacognitive reflection was encouraged in students so that they could individually monitor and self-correct their own behaviours.

Teachers came to use the framework of different types of engagement to critically but constructively interrogate their practice. For example, a common

activity in elementary schools is to build and set off a model volcano using bicarbonate of soda and vinegar in a paper mache volcano vent. It is dramatic and children love it, but two teachers looked at this part of their practice and decided that it only generated affective engagement –since volcanic eruption has nothing to do with chemical reactions it was actually cognitively misleading. The result, they dropped using this demonstration with their students.

**Interactions with other focal concepts – tying back to Shulman**

The focus of this paper is on routes to student engagement as part of pedagogical reasoning. However, this was only one of five key focal concepts that emerged from the 40 teachers included in this study. The others being Big ideas, Generation of quality learning and quality learners, Responding to contextual constraints and opportunities, and Teacher personal and professional identify. What was noted in mapping teachers’ planning conversations was taht rather than a linear process as described by Shulman (1987), pedagogical reasoning appeared to move between the key focal concepts as represented in Figure 2.

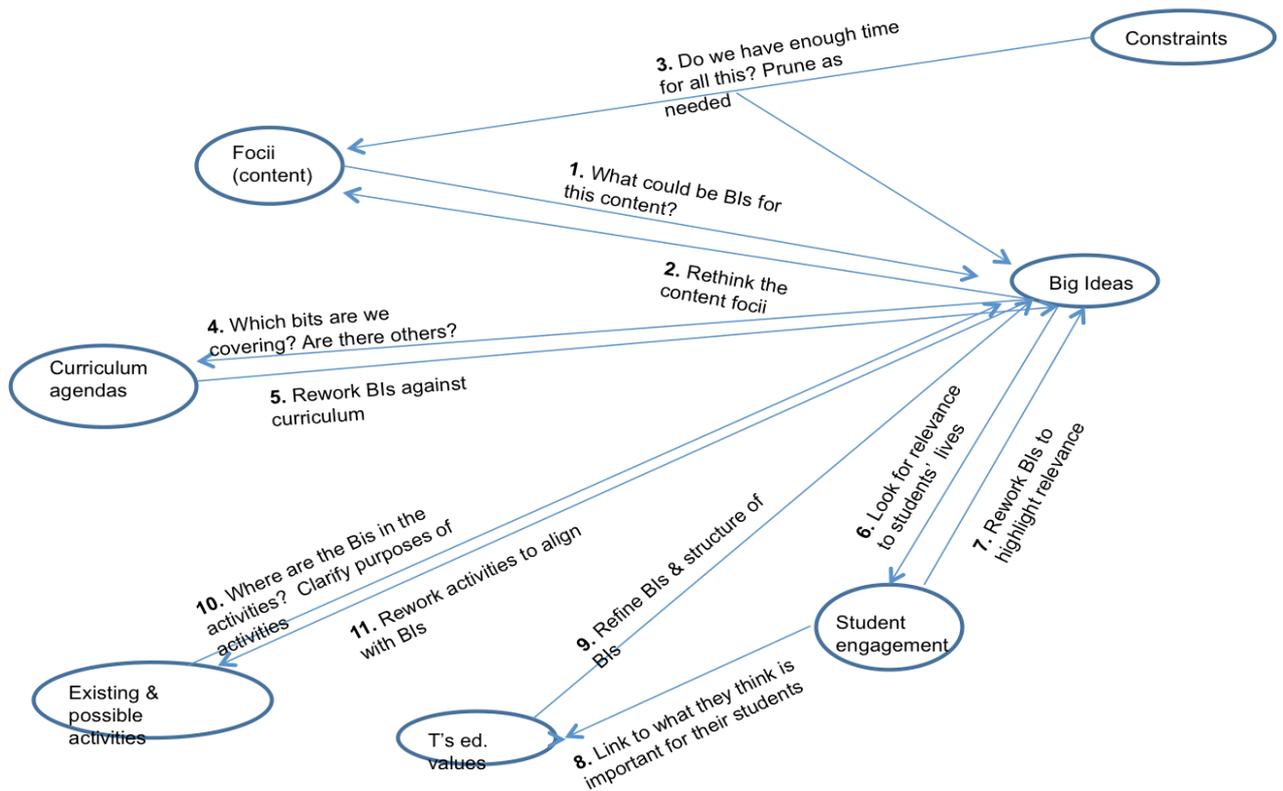


Figure 2. Pinball reasoning demonstrated in teaching planning

As such this highlights the complex interplay that occurs often in expert teachers’ heads as they plan their teaching in ways that enhance and support student learning in science. We have termed the

quick and frequent movement of thinking between these focal concepts evident in this figure as ‘pinball reasoning’ thereby counteracting the rather linear view of teacher preparation to teach proposed

initially by Shulman in 1987. One thing this meant for teachers' thinking about engagement was that this thinking could be and was stimulated by any of the other foci. For example, a constraint and/or opportunity identified by teachers might be around the content - volcanoes are exciting and offer easy ways into engagement, but some content (e.g. the periodic table) is abstract and boring and this judgement often led to discussion about how to make it engaging. In the case of the periodic table, the teachers decided to personalise Mendeleev, both the problems he faced and his scandalous private life. The key point being made here is that while the individual foci were identified, in designing and planning for student learning, teachers quickly and consistently moved backwards and forwards between these five foci. This type of mapping of movement demonstrated quite clearly the complex nature of teaching even in the preparatory phase.

### Concluding statements

Our data supports the assertion that different dimensions of engagement reflect different core purposes of teaching. It is important to note that this was not a random group of teachers but rather teachers identified over several years of engagement in professional learning programs as teachers with considerable expertise around the teaching of science. Expertise is used deliberately to mean more than experience but rather teachers who seek to reflect upon and improve their practice over considerable time. For the teachers in this study, the core purposes of student engagement were focused towards building quality learning within a community of learners rather than on merely behavioural outcomes. There was no deficit discourse apportioning blame to students, nor concerns about behavioural engagement. Rather these teachers used sophisticated thinking about their students from a quality learning perspective when considering ways to engage them in the classroom. They had long-term learning agendas that ran parallel to their content agendas for developing quality learning, such building agency and metacognition.

It was clear from their practice that engagement was highly contextualised to the individual teacher and school, the topic and the particular task. Having said this, generic routes to engagement emerged based on the purposes of promoting quality learning with students where they had some control over their learning and the learning process. As Harris (2011) identified, while it is reasonable to consider engagement in school for social development, at the core of education there must be a focus on students' learning. Expert teachers realise this and strike a balance between affective, cognitive and metacognitive engagement when working with their students.

Importantly, these teachers developed routes to engagement as part of a very rich and multi-faceted process of pedagogical reasoning. In mapping teachers' discussions it was clear that routes to student engagement was inextricably linked to the four other foci as they planned their teaching. This *pinballing* between foci demonstrates the complexity of pedagogical reasoning held by expert teachers of science.

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