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How Can Professional Standards Improve
the Quality of Teaching and Learning
Science?

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Dr Ingvarson is internationally recognised for his research on professional development in the teaching profession. He has worked closely with teacher and principal associations in the development of professional standards as a means of strengthening the important role they play in relation to professional development and the provision of recognition to teachers who attain high standards of practice. With members of these associations, he has pioneered the development of new standards-based methods for the assessment of teacher and school leader performance and laid the foundations for a national, voluntary system for advanced professional certification in the teaching profession. Recently, he has been a member of Ministerial Advisory Committees for the Victorian Institute of Teaching, the TAFE Development Centre and the National Institute for Quality Teaching and School Leadership.



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Anne Semple was a teacher of science for over 30 years prior to becoming a Science Project Officer at the Victorian Curriculum and Assessment Authority (then the Board of Studies), a Research associate at Monash University and a Research fellow at ACER (Teaching and learning research program and Assessment and reporting research program). She has extensive experience in the development of curriculum and teacher and students materials (print and online) and has conducted many professional learning programs and sessions on a variety of themes. She is a past president of the Australian Science Teachers Association and has a strong and ongoing commitment to the teaching profession. Currently, Anne is an independent education consultant.

Introduction

After extensive national consultation, the recent Review of Teaching and Teacher Education (DEST 2003) announced an 'agenda for action' in its report, *Australia's Teachers: Australia's Future*. One of its central themes was a call to 'revitalise the teaching profession'. The report recommended that:

- National standards for different career stages should continue to be developed by the profession.
- A national, credible, transparent and consistent approach to assessing teaching standards (should) be developed by the teaching profession with support from government.
- Teacher career progression and salary advancement (should) reflect objectively assessed performance as a teaching professional.
- Recognition, including remuneration, for accomplished teachers who perform at advanced professional standards and work levels (should) be increased significantly.

In making these recommendations, this Review was consistent with many reports over the past 30 years related to the teaching profession. Examples include the Karmel Report in the early 1970s; the NBEET reports on teacher quality and award restructuring in the late 1980s; *A Class Act*, the report of the Senate Inquiry into the Status of Teaching (1998); the *National Statement from the Teaching Profession on Teacher Standards, Quality and Professionalism* (2003); and the report *The Status and Quality of Teaching and Learning of Science in Australian Schools* (Goodrum, Hackling & Rennie, 2000).

These reports recognised that teacher quality is critical to school and student success. A common theme, therefore, was the importance of strengthening the capacity of the profession to

develop and apply its own standards because this was regarded as the foundation for attracting, developing and retaining effective teachers.

For example, to improve the status of teaching, the 1998 Senate Inquiry called for a national system for professional standards and certification for teachers based on the achievement of enhanced knowledge and skills to retain the best teachers at the front line of student learning. The Goodrum report recommended that incentives be provided to attract larger numbers of quality students into science teaching and to retain experienced teachers in the classroom.

However, the evidence is clear that shortages of mathematics and science teachers continue. Higher earnings are required not only at the start, but throughout career paths to retain highly qualified and effective teachers. One-off recruitment schemes with golden handshakes and various incentives and bonuses are unlikely to have sustained effects (Webster, Wooden, & Marks, 2004). Any serious attempts to improve the quality of teaching and learning in science will need to improve both relative salaries and incentives to reach high professional standards if these perennial problems are to be overcome.

The success of such reforms, however, will depend fundamentally on research that informs the development of valid methods for evaluating the capacity of teachers to provide their students with high-quality opportunities to learn science. Without the capacity to evaluate teaching, it is difficult to place more value on good teaching. An important research challenge is to learn how to reform pay systems for teachers in ways that attract and retain effective teachers, without the negative effects of previous approaches such as merit pay.

In this vein, the purpose of this paper is to provide a brief review of

preliminary work at ACER, conducted in collaboration with the Australian Science Teachers' Association, to develop a standards-guided professional learning system that would lead to professional certification for highly accomplished teachers of science.

Background

The Australian Science Teachers' Association (ASTA) has long held a vision for improving the teaching of science in Australian schools. Twelve or so years ago ASTA recognised the need for articulating clearly what teachers of science should know and be able to do as they gain experience and advance in their career. It recognised the imperative for the association, as the peak body representing teachers of science across Australia, to develop and demonstrate its capacity to give professional recognition to teachers of science who achieve against these standards.

ASTA believed that such a system would provide the public and employing authorities with the assurance of quality. ASTA believed that engaging in this process would at the same time provide opportunities for deep, significant and ongoing professional learning guided by standards of practice that were directly connected to the specialised work of teachers of science. ASTA believed that improving the quality of teaching science would improve the quality of student learning. How could ASTA achieve its vision and were its beliefs justified?

This paper describes ASTA's progress towards developing a system of certification, beginning with the development of standards of practice. It describes the opportunities for professional learning that the process afforded and the effect on teachers who participated in the process. It summarises the status of development

and identifies some of the key issues that the association has to resolve if it is to continue to move forward.

The challenges facing the association were considerable. In the early 1990s, little was known or understood in Australia about how a professional teachers' association could go about developing a voluntary system of professional certification that was underpinned by an infrastructure for professional learning. Surely it was up to employing authorities to set standards of teaching practice and to provide professional development activities?

There is no doubt about the need for employing authorities to ensure that suitably qualified teachers are employed in their schools and carry out the duties expected of them. Similarly, medical authorities have to ensure that suitably qualified practitioners are employed in hospitals and other medical facilities. Where the teaching profession differs from the medical profession and others is that it lacks a process of certification that recognises advanced or accomplished practice based on meeting high and rigorous standards set by the profession.

Developing a professional certification system

The first step ASTA took was to inform itself of international experiences in the establishment of professional teaching standards and issues linking professional standards to recognising highly accomplished practice through a process of certification. In 1994, the Council commissioned such a study (Ingvarson, 1995).

After examining several models of professional certification or credentialing, the one that ASTA favoured was that of the National Board for Professional Teaching

Standards (NBPTS) of the USA for the following reasons:

- ASTA shared belief in the five core propositions that provided the philosophical context for the work of the NBPTS²;
- ASTA was impressed by the NBPTS standards of what accomplished teachers of science should know and be able to do, and by the innovative approach to developing performance assessments for teachers that were firmly grounded in the context of the work of teachers of science;
- ASTA could see the potential for professional learning during the process of completing such performance assessments;
- The National Board is an independent organisation whose governing body consisted largely of classroom teachers; and
- The NBPTS (then) had about seven years of experience in research and development in this area with a budget far beyond what ASTA could raise if it were to begin from scratch.

Components of a certification system

As ASTA's financial resources depended largely on a per capita levy on state and territory association members, Council agreed that it should seek additional funding and partnerships to further the process of developing its own certification system that would better suit the Australian context. It was not until 1999 that ASTA and Monash University won a grant from the Australian Research Council of the Department of Training and Youth Affairs Strategic Partnerships with Industry, Research and Training Scheme (ARC/SPIRT) to enable it to do so.

ARC/SPIRT grants were also obtained by Monash and three other professional associations to develop professional standards in the fields of English and Mathematics.

ASTA's research project incorporated three components that reflected the elements of a credible national voluntary system of professional certification:

1. the development and validation of standards for highly accomplished teachers of science;
2. development of performance tasks that would provide vehicles for teachers to show how their teaching met the standards; and
3. research on the reliability and validity of these tasks for wider use in a national certification system.

Development and validation of standards of practice for highly accomplished teachers of science

In 1999, ASTA established a National Science Standards Committee (NSSC) with responsibility to develop the ASTA standards. Expressions of interest were called for and highly respected teachers of science and educators were selected from all levels and all sectors across Australia. A series of intensive meetings of the 15 members of the NSSC was held in 2000 and 2001 to draft the standards. All members of the Committee agreed that developing the standards was an extraordinarily rewarding process of professional engagement, reflection on practice, and professional learning.

As teaching is such complex work, the Committee was faced with the challenge of teasing out and articulating the elements of that work without developing a mere checklist that would lose sight of teaching's holistic nature. The Committee recognised that the knowledge and skills of highly

accomplished teachers of science differed from those of novice teachers and also differed fundamentally from the knowledge and skills of teachers of other subject areas. The standards had to reflect this.

The standards also had to be achievable, measurable and context-free if they were to be the basis of a high stakes national certification system, in addition to being valuable reference points for individual or group professional learning.

The process of validating the standards involved extensive consultation with ASTA members through its state and territory associations. Professional and public comment and critique were sought from a wide range of stakeholders, including the Federation of Australian Scientific and Technological Societies, the Australian Academy of Science, state and territory departments of education, the independent and Catholic sectors, and unions. Following review and revision, the standards were published in February 2002 (National Science Standards Committee, 2002).

The 11 professional standards for highly accomplished teachers of science are grouped in three categories:

1. **Professional knowledge:** Highly accomplished teachers of science have an extensive knowledge of science, science education and students (3).
2. **Professional practice:** Highly accomplished teachers of science work with their students to achieve high quality learning outcomes in science (6).
3. **Professional attributes:** Highly accomplished teachers of science are reflective, committed to improvement and are active members of their professional community (2).

²Five core propositions of the NBPTS [<http://www.nbpts.org/about/coreprops.cfm>]

Each of the 11 standards consists of a short statement that distils the essence of the standard, followed by an elaboration that paints a word picture of the practice of a highly accomplished teacher of science in relation to the standard. The full set of ASTA standards is over 20 pages long and can be found on the ASTA website.

Development of performance assessments based on the standards

A certification system not only involves the development of professional standards but also the development of tasks that provide authentic evidence of performance of teaching practice that can be assessed against the standards. This stage of the ASTA/Monash project commenced in 2000 and consisted of two phases.

Phase 1: 2000 – Trialling of NBPTS portfolio entries

The NBPTS had commissioned considerable research and engaged many leading figures in educational measurement in developing methods for gathering and assessing evidence about teacher performance. Based on ASTA's earlier 'in principle' acceptance of the NBPTS model, and rather than reinventing the wheel, teachers were invited to trial the five NBPTS 'entries' or tasks that comprised a complete portfolio, and to evaluate them in terms of:

- how appropriate the NBPTS portfolio tasks were for providing evidence of accomplished practice in the Australian context, and
- how appropriate the NBPTS portfolio tasks would be as a means

for assessing performance against the ASTA professional standards

Portfolio Evaluation Teams (PETs) were established in Victoria, Western Australia, New South Wales and South Australia. As part of the research project, each teacher was asked to trial and evaluate one of the five entry tasks that would constitute a complete portfolio. Due to competing demands for their time and other mediating factors, the attrition rate of members of PETs was high. This highlighted the need for a high level of national, structured collaboration and a supportive infrastructure, particularly at school level, to facilitate such a process.

Nine individual PET members were able to complete and submit their entry and the evaluation questionnaire. Group responses were received from two Portfolio Evaluation Teams. All agreed strongly that:

- overall the portfolio tasks were authentic for the Australian context – the tasks were asking for evidence of what should normally be part of the work of a teacher of science in Australia
- the tasks would discriminate between novice and highly accomplished practice
- teachers would be able to use their own styles and strategies of teaching to meet the needs of their students
- the tasks were clear and fair and designed appropriately for them to be able provide evidence for assessment against the standards³.

Apart from evaluating the portfolio tasks, teachers were invited to reflect on their experience. The following is a representative sample of teachers' views.

Putting together a portfolio entry (video) certainly was a challenging and

time-consuming experience. However, the benefits for me as a professional were far greater. The chance to see myself teach and reflect upon my practice, although daunting, enabled me to look closely at the things that I did well, as well as look at the things I could improve on. This had obvious benefits for my class. I was able to sit back and watch my own lesson from a distance and see if my teaching methods really did support my beliefs. I was able to view the Science lesson from the student's perspective rather than simply from my own.

Phase 2: 2001 – Developing the ASTA portfolio tasks

ASTA Council had established an Assessment Reference Group (ARG) to provide advice about developing assessment tasks. It consisted of members of PETs and the NSSC and educators who had undertaken assessment training and benchmarking with the NBPTS in the USA.

The findings of the PETs and advice from the ARG informed the writing of the ASTA portfolio entries. Writers included well-respected teachers of science, teachers who had trialled NBPTS portfolio entries and those who had undertaken assessment training. As with the development of the standards, the process offered opportunities for significant professional learning.

Five portfolio entries were modelled on the NBPTS framework.

1. *Teaching a major idea of science over time*: teachers provide evidence of how they design a teaching and learning program or unit of work centred on a major scientific idea that enables students to develop associated skills.
2. *Assessing students' work*: teachers provide evidence of how they use

³Semple, A. (2001). *ASTA evaluation of NBPTS portfolio entries: Report of Portfolio Evaluation Teams* (unpublished), ASTA.

assessment to evaluate students' progress and further students' learning in science.

3. *Probing students' understanding:* teachers provide evidence of how they engage students in probing their prior understanding of a major scientific concept and how they modify their teaching in response.
4. *Active engagement in investigation and inquiry:* teachers provide evidence of how they engage students in discussion that involves the interpretation of data collected during an investigation of an important scientific concept.
5. *Leadership and collaboration in school and professional communities:* teachers provide evidence that their contribution extends beyond the classroom to the school and the wider professional community. They show how interactions with students' families/caregivers and the local and professional communities have contributed to their students' learning in science.

Portfolio entries 1 and 2 each required detailed critical analysis of and reflection on student work samples; each of entries 3 and 4 required detailed critical analysis of and reflection on an unedited 20-minute video recording of class interactions. The Portfolio 5 entry required verified evidence of active leadership and a written reflection on the effects of such professional activity on their students' learning in science.

Portfolio entries, based on the NBPTS framework, were designed to make it clear *what* kind of evidence teachers had to provide and how the evidence would be assessed, but to leave open *how* teachers fulfilled the requirements. This format reduced the chance of ambiguity in interpreting expectations (and therefore were legally defensible), yet took account of the different contexts in which teachers work. It was important for teachers to realise that

having standards of practice did not mean standardisation of practice. Each portfolio task is structured so that it provides evidence relevant to several standards and retains the wholeness of teaching. And, the portfolio entries, as a set, provide several independent pieces of evidence about each of the standards, increasing the reliability of the assessment.

Despite teachers initial concerns that they were able to submit everything that they thought relevant, there was general agreement that the structured format with guideline questions helped them to represent their teaching in the best possible light. There was:

'relief that there **were** boundaries! The imposed word limit meant you had to remain quite focused and really home in on the key ideas. Having set standards meant that everyone else would face the same constraints.'

Research on the reliability and validity of the assessment tasks (portfolio entries)

The next phase of the research project required larger numbers of teachers to complete portfolio entries so that their measurement properties could be evaluated, such as their ability to be assessed reliably by trained peer assessors. The next phase also required the development of a support structure to help teachers to prepare their entries.

In total, 45 teachers completed one of the ASTA developed portfolio entries in 2001 and 2002. After they had completed the entry, teachers were invited to assess:

- whether the draft tasks were appropriate for assessing practice against the ASTA draft standards

(i.e. were they authentic, assessable and feasible?); and

- the effects that completing a portfolio entry had on their professional practice and professional interactions with colleagues.

A brief description of the support program follows.

Setting up an infrastructure for professional learning

Research findings of the NBPTS and the experience of members of the Australian PETs (2000) indicated strongly that teachers wanted, and benefited from, collaborative and ongoing support and interaction through the process of preparing portfolio entries. In collaboration with the Australian Council for Educational Research (ACER), a six-session professional learning program, *Relating professional standards to practice*, was designed based on the ASTA standards and what research at the time revealed about best practice in professional development (Hawley & Valli, 1999; National Academy of Science, 1995).

Funding to assist teachers through the trialling process was obtained from education departments in South Australia, Victoria and New South Wales, the Catholic Education Commission in Victoria and by individual schools through the Association of Independent Schools in South Australia. Some independent schools in Victoria covered the cost of their teachers' participation. Member associations of ASTA collaborated in the delivery of the program and university credit was arranged for teachers who wished it. One teacher took advantage of this opportunity.

Gathering the evidence to complete their portfolio entry over a period of up to eight months engaged teachers in authentic problems of teaching and

student learning. Facilitated learning, sharing practice and discussion with peers supported teachers through the process of viewing, analysing and reflecting on their work that involved tracking the progress of students' learning in a variety of contexts.

Participants were asked to complete two questionnaires, one to evaluate the nature and process of completing the portfolio entries⁴ and the other to evaluate the professional development program that supported them in the process.

Findings

Portfolio tasks

In summary, all participating teachers agreed or strongly agreed that each of the five portfolio tasks was authentic, assessable and feasible. About a third of the teachers who completed an entry requiring videotape of their lessons found some difficulties in arranging for videotaping and using video cameras. Despite initial concerns, teachers valued the experience of seeing themselves and others in action.

'Seeing yourself (and hearing) on video shows certain flaws and, although you may think you cover something well, the video will/ may show something different. I thought I cover asking every one in the class well – but not at all! The video also shows members of the class and their levels of participation, especially when you are not asking them information – but the video is still on them.'

The opportunity to analyse and reflect on their practice provided powerful learning opportunities for all respondents.

'When I finally finished the entry, I looked back on my endeavours with pride. While it was far from

perfect, I gained many ideas for improvement. I am more confident about sharing my practice with others. There is value in having a formal structure on which to compare practice with others. This opportunity to reflect on teaching and consider ways of improving practice should be available to others. I certainly found it to be a worthwhile exercise. It gives teachers something to aspire to and work towards achieving specific standards. There is a tangible purpose to improving practice and the possibility of developing a reward system for achieving those standards.'

Another teacher commented:

'The process allowed me to reflect upon the manner in which my activities outside the classroom impact on successful study of science by all students in my school. This has allowed me to refine aspects of my management and reinforced my commitment to this aspect of my role.' (Entry 5)

Some teachers referred to the value of having professional standards to guide them in their teaching and in their professional learning.

'I now have a set of standards which I can adhere to throughout my teaching ...'

'For the first time in many years I have had a structured way of analysing and reflecting on my science teaching. I have successfully completed AST I assessment and the application/selection process for promotion. However, my classroom teaching in the specialised area of science has not been specifically analysed. I believe that long-term, this process will significantly benefit my teaching of science and my input into discussion of effective teaching at school.'

Professional learning program

Finding and managing time to participate in the program and complete a portfolio task in a busy teaching schedule, and the degree of support offered at the school level were problematic for some teachers.

'It's difficult finding time for sessions and to do work in between ... because it's worthwhile doing it – it's fantastic, I'm glad I went. The cost of the program makes it difficult to take part. If the budget is slashed, PD is the first to go.'

However, teachers valued the opportunity to discuss their work.

'... getting together with others; the focus on teaching; it's able to be used in the classroom – it's relevant and therefore more effective. It's highlighted the ways students learn and made me look deeper into the learning environment and how they learn. It's been an incredibly invaluable experience for me – access to people, hear how they function, curriculum and so on ... it's benefited me early in my career.'

In all, about 80 teachers have taken part in these programs of professional learning strongly linked to their work. Approximately 40 entries, distributed across the five components of a portfolio, were submitted by primary and secondary teachers of science. Generally, participants agreed that they had been challenged, that their professional knowledge had expanded and deepened, their practice improved – even revitalised in some instances – and in the majority of cases, their professional interactions had benefited.

Though evidence of the direct and measurable effect of these changes on student learning has yet to be established, many teachers reported on improvement in their students'

⁴Semple, A. (2001). *Developing standards-based performance assessments for teachers of science*. (unpublished) ASTA/ACER.

attitude and interest in learning science, that they generally had a clearer understanding of their learning and that they were better able to judge their progress⁵.

ASTA's vision: What has been achieved?

The work reported here has been guided by a vision in which teacher organisations like the Australian Science Teachers' Association would play a stronger role in developing profession-wide standards for highly accomplished practice and providing certification to teachers who reached those standards. A full set of standards points to how evidence about capability and performance will be gathered, and how decisions will be made about whether the standards have been met.

This paper has summarised preliminary research at ACER, conducted in collaboration with ASTA, to develop new methods for gathering evidence about teaching performance that might be used in a system for providing recognition to highly accomplished science teachers.

The work reported here indicates that ASTA has made considerable progress towards developing a professional certification system. It has also described how the process of working towards standards for highly accomplished science teaching and assembling evidence in relation to those standards provides significant professional learning opportunities for teachers of science. The shared process of describing, analysing and reflecting on how one's teaching compares with professional standards engages teachers in effective processes of professional learning.

Improving the quality of science learning in our schools will undoubtedly require

more effective policies and career pathways for attracting, developing and retaining effective science teachers. For these policies to work, we will have to find credible methods not only for defining what we think good science teachers should know and be able to do, but also for gathering evidence about performance and assessing whether that evidence indicates that the standards have been met. We need to get better at evaluating teaching if we are to find acceptable methods for giving recognition to teachers who reach high standards of practice.

In other words, this paper makes clear that the teaching profession is beginning to build its own infrastructure for defining high quality teaching standards, promoting development toward those standards and providing recognition to those who meet them. The ASTA initiative, and others like it, such as that of the AAMT, is demonstrating that the teaching profession has the capacity to build a standards-guided professional learning system that will strengthen the quality of science teaching and learning in our schools. These initiatives are very much in the interest of governments and other employing authorities and therefore to be encouraged through better remuneration and career paths that better reflect what a highly accomplished science teacher is worth, not only to their school, but to our society and our economy.

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⁵Report of the National Professional Development Program (2001). ACER (unpublished).