The Science Learning and Teaching Academic Standards project: a discipline community's response to regulatory change in Australian higher education

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In 2010, the Australian Federal Government announced their intention to establish the Tertiary Education Quality Standards Authority (TEQSA) to audit tertiary education institutions against new standards, including standards for graduate learning outcomes. This induced significant sectoral concern about potential 'perverse consequences' such as standardisation of curricula. In response, the Australian Learning and Teaching Council (ALTC) funded the Learning and Teaching Academic Standards (LTAS) project to support discipline communities to develop graduate learning outcomes for nominated degrees. This paper provides a sociological analysis of the LTAS project for Science. We reflect upon the process of attaining national endorsement of science threshold learning outcomes (TLOs) through a fundamentally collegial project design: consulting academics, students, employers and graduates in science professions. Project data were analysed by varying the unit of analysis, and using different theoretical frameworks from Science Technology and Society (STS) literature to elicit insights about the process and outcomes of the project. Activity Theory allowed us to interpret the project as intitiating a cycle of expansive learning; Communities of Practice theory provided insights into the catalytic role of the Discipline Scholars. In leading a discipline-community response to quality assurance requirements of higher education awards, the LTAS project provided a social framework for defining and evidencing graduate capabilities, including ongoing engagement.

Keywords: discipline community, learning outcomes, graduate workforce capability

Introduction

In 2009, the Australian Federal Government announced a new national approach to higher education regulation and quality assurance. They would establish the Tertiary Education Quality Standards Authority (TEQSA) to audit institutions against five sets of standards, including standards for graduate learning outcomes. This announcement led to significant sectoral concern about potential 'perverse consequences' including homogenisation of university curricula and standardised testing (Elson-Green, 2009). The Australian Learning and Teaching Council (ALTC) responded proactively to the anticipated changes by instigating the Learning and Teaching Academic Standards (LTAS) project to support 'disciplines setting standards' (ALTC, 2011a). Selected discipline communities would develop and achieve formal endorsement of national-level learning standards for nominated higher education (HE) degrees. The project was designed as a collegial process: consulting all

stakeholders (academics, students, graduates and employers) was fundamental to achieving consensus on what a graduate should know and be able to do entering the workforce.

The LTAS project was grounded in the intrinsic value of maintaining academic independence and self-regulation in the design of curricula whilst acknowledging the importance of developing standards for accreditation of courses of study (ALTC, 2011a). The underlying premise was that a discipline-led collegial approach would produce an outcome that was both acceptable to HE educators and aligned with employers' expectations of graduate capabilities. Importantly, the LTAS project aimed to foster an ongoing commitment from academics to integrate the new standards into their educational practice. The project represented, therefore, an academic development exercise of national scope, situated within a complex HE context with social, historical, and political factors impacting educational decisions.

This paper presents a sociological analysis of the LTAS project for Science. Theoretical frameworks for analysis were drawn from Science, Technology and Society (STS) studies. STS encompasses sociology of scientific knowledge and utilises a wide range of theoretical lenses and largely qualitative methods to include social, political, historical and cultural perspectives on the social construction of knowledge (Restivo, 2005). In particular, the authors reflect on the process of attaining national endorsement of science threshold learning outcomes (TLOs) and emergent outcomes. Different lenses suggest interpretive possibilities and insights: Activity Theory (Engeström, 2001) is employed to interpret the project as a cycle of expansive learning; Communities of Practice theory (Wenger, 1998) to elicit insights into the catalytic role of the project leaders.

The LTAS Science project

The LTAS-Science project (July 2010 - June 2011) was led by Discipline Scholars Susan Jones and Brian Yates with Project Officer Jo-Anne Kelder. The key project deliverable was the Learning and Teaching Academic Standards Statement for Science (Jones, Yates & Kelder, 2011), the core of which was a set of TLOs for bachelor level degrees in science developed through discussion with the national science discipline community.

Project methodology

The methodology of the LTAS-Science project was grounded in a philosophy of education as a collegial activity characterised by community values of collaboration and consultation. The 'science discipline community' was conceived broadly as individuals or groups committed to tertiary level science education. It included university academics (researchers and teachers), representatives of professional bodies, employers, graduates and students.

The project (see also Jones, Yates & Kelder, 2012) used a systematic approach to developing the Science Standards Statement (SSS) over three phases: pilot; consultation and communication; endorsement and publication. The approach was developmental: each phase included consultation activities and built on the outcomes and learnings of the previous phase. Forms of interaction were constructed to include conversational elements (Haigh, 2006) within a defined structure and order. In Phase One, consultation was targeted at specific groups with particular characteristics (representativeness, influence, expertise, engagement). Phase Two consultation was broad and inclusive, targeting self-identified members of the national science discipline community. Phase Three consultation narrowed to specific groups for targeted advice on final formulation of the SSS.

The LTAS – Science project as a sociological 'story'

The Final Project Report (ALTC, 2011b) detailed the challenges and successes of the project in terms of the extent to which aims and deliverables were achieved within time, quality and budget constraints. Jones et al. (2012) described the project's key activities, and reflected on how the outcomes, specifically the Science TLOs, were being utilised, with suggestions for future steps. However, from a broader perspective, the 'story' of the LTAS – Science project can be framed as a sociological story within the context of STS literature. A sociological framing of the project provides a theoretical foundation for understanding key relationships between the initiating context of the project, interactions within the project structure, and its impact and outcomes. It allows us to identify implications for other broad scale academic development activities.

The warrant for sociological analysis was grounded in the social characteristics of the LTAS project. The ALTC (2011a, p. 41) described the purpose of the LTAS project as "starting the conversation" within discipline communities in response to the changing regulatory environment. The project design embedded project leaders (Discipline Scholars), selected as "well-regarded" leaders in their discipline, with responsibility for the "process" of engaging stakeholders. The foci were standards of accountability and benchmarking of student learning outcomes from stakeholders' perspectives, highlighting issues, and creating networks to continue the conversation after the project's conclusion (ALTC, 2011a). The goal, design and terminology used to articulate the project's purpose and activities align with the philosophy of knowledge as socially constructed (Burr, 2003).

Method

The analysis presented in this paper was conducted at the end of the project. The data comprised all information generated during the conduct of the project (for example: newsletters, survey responses, workshop materials, project reports, meeting minutes, correspondence, and team members' reflections). This information was structured for project management and reporting purposes. Thus, in order to develop a sociological 'story' of the project, we structured and organised the data to first, facilitate answering the research questions, and, second, suggest appropriate theoretical lenses for further analysis and interpretation.

Analysis 1: thematic analysis

A thematic analysis, using the approach outlined in Braun & Clarke(2006), of documents related to the project set-up and methodology, was undertaken to identify those characteristics of the LTAS-Science project that contributed to achieving the project outcomes, particularly the guiding principles for decision-making by the project leaders in the design and conduct of the project. This analysis determined: *what characteristics of the LTAS – Science project were key to achieving consensus on project outcomes and engendering enthusiasm for their implementation in an uncertain and complex climate for higher education?*

Six themes identified were: *people as catalysts, choosing a broad focus, integrated activities and interconnected structures, gatekeeper support and endorsement, engaging stakeholders in consultation, iterative cycles of development* and *planning for sustainability.* These themes particularly related to the project task of engaging in a national consultation with stakeholders to produce an agreed statement on the nature of Science as a discipline, as well as a set of Threshold Learning Outcomes (TLOs) for science graduates.

The project leaders were titled ‘Discipline Scholars’, indicating their status as leaders in the disciplines of Science and Science Education (Elson-Green, 2009). The Discipline Scholars were the primary instance of *people as catalysts*, selected to lead the project on the basis of being “well-regarded” and able to engage with their discipline community. In their own words:

> Essentially, our role was that of catalyst. … the key to the success of the LTAS Projects was a sense of shared ownership of the outputs by the national discipline body. (DS reflection16/10/2011)

> I think that one of our ‘attractions’ [as Discipline Scholars] is that we had/have no particular institutional or political barrow to push … but were genuinely perceived as working for the good of the sector as a whole. The LTAS project did represent an investment by a broader constituency for a communal purpose. (DS reflection 07/02/20120

Workshops were designed to ensure the project was *engaging stakeholders in consultation* to develop the Science Standards Statement (SSS). The key to success was a local organiser (usually Associate Dean Teaching and Learning). Their role was *gatekeeper*, providing organizational *support and endorsement* of the value of engaging in the workshop to local academics, students, and/or employers of their graduates). The theme of *gatekeeper support and endorsement* was most clearly and critically applied in the ACDS’s promotion of the LTAS-Science project and their formal endorsement of the Science TLOs.

As already noted, the proximate goal of the LTAS – Science project was to construct the SSS. Decisions on the method were guided by the project themes *choosing a broad focus* (TLOs for Science) and *iterative cycles of development* of the SSS. Longer-term goals were embedded in the project theme *planning for sustainability*. To this end, the ALTC “granted project funding to continue the conversation into other standards-related areas within their broad discipline areas throughout 2012” (ALTC 2011a, p. 41).

Analysis 2: applying the PPT-construct and theoretical frameworks

This analysis was conducted to answer a subsequent research question: *What social outcomes can be linked to the people, activities and deliverables of the LTAS – Science project?* First, Activity Theory (Engeström, 2001) was applied to analyse the LTAS – Science project as initiating a *cycle of expansive learning.* Second, the constructs *broker* and *boundary object* from Communities of Practice theory (Wenger, 1998) elucidated the role of the project leaders and the emergent influence of the Science Standards Statement across the Science discipline community in Australia.

Science Technology and Society (STS) literature provides a range of theoretical lenses, methods and techniques for analysing social practices, interactions and processes that are present in knowledge construction activities. The method of analysis adopted for this paper draws on a technique articulated in Kelder and Turner (2008) and Kelder (2009) that provides a structure for exploratory data analysis to identify: 1) a focus (unit of analysis); and 2) candidate theoretical frameworks that fit the nature of the data and support answering the research question. Candidate theoretical frameworks are evaluated by a heuristic device, the “People, Place and Thing” (PPT) construct (Kelder, 2009; Kelder & Turner, 2008). The PPT construct is aligned with actor network theory, concepts of trajectory and interactions between networks of human and artefact actors (Latour, 2005). It guides the initial framing of a sociological inquiry into a setting with a range of data sets to trial different ways of selecting

and organising data for analysis productive of insights.The PPT- construct acts as a sensitising lens that guides the researcher's thinking about a setting in terms of trajectories of data: dynamically changing configurations of interacting *people, place and things* (Kelder, 2009; Kelder & Turner, 2008). An underlying assumption is that human interactions are context-specific, dynamic, purposeful, and usually connected to (or organised around) a problem to be addressed.

The PPT analysis uses focus questions to identify trajectories of PPT-element (*people, thing or place*) interactions occurring over time in the LTAS – Science project and to select the focus of further analysis. A PPT-element that is selected for further analysis is present in trajectories connected to purpose-driven (or problem-addressing) activities. Table 1 summarises data, structured by focus questions to identify the key PPT-elements and PPT-trajectory, for further analysis.

Table 1. People, Place and Thing (PPT): PPT-elements and PPT-trajectory for further analysis.

Focus questions	**Potential PPT-elements and PPT-trajectory for further analysis**
PEOPLE Which people form the locus of the interactions in the setting? What is the locus of attention in their interactions?	a) Individual actors: LTAS project Director, Senior Project Officer, national project support staff (communications officer), *Discipline Scholars*, Project Officer, science academics, Associate Deans Teaching and Learning (Science), academics (science higher education (HE) focus), employers, graduates, students b) Social groupings within Science Discipline: Peak bodies, ACDS, Reference Group, Advisory Group, Local Reference Group, contacts listed in database, consultation workshop participants **Focus**: *Science Standards Statement*
PLACES What are the places in which interactions occur and what is their role?	Australian university campuses: *Discipline Scholars* leading consultation workshops with stakeholders in science HE University of Tasmania: *Discipline Scholars* meetings with Local Reference Group Australian Learning and Teaching Council headquarters: *Discipline Scholars* meetings with Reference Group, Advisory Group, national LTAS project *Discipline Scholars* meetings
THINGS What thing(s) form the focus of interactions in the setting?	Online survey instrument, workshop feedback sheets, *Science Standards Statement* draft,communication technologies (video-conferencing, telephone, email, laptops, iPads, data projectors, e-whiteboards, MS Office Excel and Word, SurveyMonkey), project newsletters, LTAS national project templates
Key PPT elements Which PPT elements are the locus of a problem-addressing or purpose-driven PPT-trajectory?	**Problem/Purpose PPT-trajectory**: to develop the *Science Standards Statement* for national use in Science HE **Key People**: *Discipline Scholars* (interacting with Science HE stakeholders) **Key Place**: - Higher Education **Key Thing**: *Science Standards Statement*

The focus (purpose) of all PPT-trajectories of interactions, and also the focus of attention of all actors engaging in the project was the construction, endorsement and dissemination of the *Science Standards Statement* (SSS) (Table 1). Likewise, the *Discipline Scholars* were the key actors in the development of the *SSS*: their activities were tightly connected to the trajectory of its development.

The PPT-guided analysis resulted in the decision to focus on the trajectory of interactions involving the *SSS* (Thing) and *Discipline Scholars* (People) over the duration of the LTAS

project and to investigate candidate theoretical frameworks for analysing: 1) the development of the *SSS*, its role and purpose (Activity Theory); and 2) the role (among the science discipline stakeholders) of the *Discipline Scholars* and of the *SSS* (Communities of Practice theory). Selection of an appropriate framework for analysis was based on the unit of analysis and constructs specific to the framework in relation to the research questions.

Activity Theory and Communities of Practice Theory

Activity Theory is an approach for understanding the social construction of knowledge (Engeström, 2000). It engenders thinking about interactions or relationships within an activity as culturally and historically mediated (Engeström, 1999). Different forms of human practices can be studied as development processes, interlinking individual and social levels (Kuutti, 1995). One of five principles underpinning Activity Theory is *expansive cycles of learning* that engender transformation in an activity via collaborative envisaging and collective efforts toward change (Engeström, 2001). Expansive learning arises from contradictions, defined as "historically accumulating structural tensions within and between activity systems" (2001, p. 137). Activity Theory provided constructs that could be applied to describe and explain the role and impact of the *SSS* in the context of its development as well as its intended and actual use within the Science discipline community.

Communities of Practice is a social theory of learning emphasising personal trajectories of change in practice: its focus is on the individual (Wenger, 1998). Brown and Duguid (2000) have a similar theoretical practice-based perspective, but shift the focus from the individual to the relational forces of sharing knowledge within and across communities of practice (Østerlund & Carlile, 2005): knowledge emerges out of collective effort around shared practice in a community unit of analysis. Communities of Practice theory was selected because its unit of analysis, *social production of meaning*, places analytic focus on stakeholders who engaged with the LTAS-Science project as a *community of practice* and also as a more loosely connected social grouping *network of practice* (Brown & Duguid, 2000). It also provides a conceptual framework for articulation of the role of the Discipline Scholars as *brokers*, and the SSS as a *boundary object* operating as a shared artefact for a network of *communities of practice.*

> Boundary objects are objects which are both plastic enough to adapt to local needs and constraints of the several parties employing them, yet robust enough to maintain a common identity across sites. They are weakly structured in common use, and become strongly structured in individual-site use. They may be abstract or concrete. They have different meanings in different social worlds but their structure is common enough to more than one world to make them recognizable, a means of translation. The creation and management of boundary objects is key in developing and maintaining coherence across intersecting social worlds (Star and Griesemer, 1989, p. 393).

Thus, an artefact is a *boundary object* when it belongs to multiple social groups (communities) with different perspectives, is usable for different practices and differing purposes, and enables coordination or collaboration (Star & Griesemer, 1989; Wenger, 1998).

The PPT analysis produced a data structure (summarised in Table 2) that related constructs embedded in two theoretical lenses (Activity Theory and Communities of Practice), with their units of analysis, to interpretive possibilities for data generated during the LTAS – Science project. Each lens was used to guide the analysis construction of a narrative, or 'story,' of the project in relation to the research questions.

Table 2. Applying theoretical constructs to structure data

Theory Constructs	Unit of analysis	PPT - Analysis focus (SSS and DSs)
Activity Theory • interactions mediated by tools, rules, community and division of labour with purposeful activity • cycle of expansive learning initiated by contradictions within or between activity systems	Activity / purposeful human activity system	**Science Standards Statement (SSS)** • cultural and historical context • constructing a tool **Discipline Scholars** • Subject of activity • Object (purpose) = develop SSS with stakeholder ownership (community)
Communities of Practice • mechanisms for sharing and distributing knowledge and information • community of practice, membership, broker • boundary object, • network of practice (Brown and Duguid 2000)	People engaged in social production of meaning, connected by shared practice and interest in a knowledge domain	**Discipline Scholars** • broker role • broker with institutional authority **Science Discipline community** • community of practice • network of practice of science educators and stakeholders (students; employers) • membership – academics, students, graduates, employers **Science Standards Statement** • Constructing a boundary object

The description attached to the constructs, and the theory of how the constructs relate to each other, is the basis on which the project can be understood from two different perspectives: first, in terms of a human activity system and second, in terms of a community of practice. The interpretive narrative, focused on the Science Standards Statement (SSS) and the Discipline Scholars (DSs), is anchored to a body of research that seeks to understand and articulate knowledge as a socially constructed phenomenon.

Interpretation

This section interprets the development and role of the SSS and the activity and role of the Discipline Scholars from the different perspectives of Activity Theory (Engeström, 2001) and Communities of Practice theory (Wenger, 1998).

LTAS – Science project as a cycle of expansive learning – Activity Theory

The project was analysed as a human activity system (*sensu* CRADLE Centre for Research on Activity, Development and Learning, n. d.) engaged in a short-term goal-directed activity: to develop the SSS. It is described in terms of 'subject' and 'object' (purpose) connected by sets of mediating relationships via 'rules', 'instruments (tools)', 'community', and 'division of labour' and occurring in the context of a seven-step cycle of expansive learning: 1) questioning; 2a) historical analysis and 2b) actual empirical analysis; 3) modeling the new solution; 4) examining the new model; 5) implementing the new model; 6) reflecting on the process; 7) consolidating the new practice (Engeström, 2001).

Discipline Scholars were selected as the *subject* of the analysis because their perspective as leaders of the project significantly prescribed its conduct. The *object*, or purpose, of the project activity was to articulate TLOs in the form of statements that universities could use as a basis for assuring threshold standards of knowledge, skills, understanding for graduates of Australian science degrees. The *outcome* of the project was therefore the Science Standards Statement (SSS). The *community* mediating relations between the *subject* and *object* included

university science academics, students, graduates, employers, project officer, Advisory Group, Reference Group, local reference group, the Australian Council of Deans of Science (ACDS), other Science-aligned peak bodies, national LTAS project team, other LTAS discipline project teams.

The LTAS – Science project used and developed *instruments* to enable collaboration and communication with the community of persons with an interest in the outcome. The alignment of objectives between the national LTAS project and the discipline projects enabled adoption and/or adaptation of tools such as document templates, online survey design, workshop plans, feedback questionnaires, contacts data base, project website and project management systems.

The design of the *division of labour* was critical to achieving the objective of Science TLOs that would be endorsed by the ACDS, published, and disseminated for further discussion, development and use. Several of the project themes that guided decision-making were dependent on a division of labour intended to optimise the Science discipline community's acceptance of the Science TLOs and their willingness to implement them in future activities designed to support quality learning outcomes for students.

The LTAS Science project was analysed as occurring within a cycle of expansive learning, intitiated by the national "Disciplines Setting Standards" project and in response to changing requirements for quality assurance in HE (contradicting values of academic independence and engendered resistance to the possibility of curriculum standardisation). The project's establishment occurred at a point where questioning and historical analysis (step 1 and 2a) could escalate "into collaborative envisioning and a deliberate collective change effort." The project design enabled expansive transformation to be accomplished by providing the context in which "the object and motive of the activity are reconceptualized to embrace a radically wider horizon of possibilities than in the previous mode of the activity" (Engeström, 2001, p.152). Thus, the project method included empirical analysis (step 2b), particularly of graduate capabilities desired by employers and international and national standards to which TLOs had to align. The iterative development of the SSS involved modelling (step 3) and testing/examining (step 4). The reports and peer reviewed publications represent reflection on the process (Step 6), overlapping with a long process of consolidation (Step 7). At the conclusion of the project in 2011, the DSs were employed to support academic discipline networks implement the SSS and many academics worked collaboratively to further develop TLOs for sub-disciplines of Science. The Agriculture LTAS Statement (AgLTAS), completed in 2014, is an example of another cycle of expansive learning that was founded on the SSS and followed a similar pathway to the Science LTAS project (Botwright Acuna *et al.,* 2013).

DSs as brokers and SSS as boundary object – Communities of Practice theory

Communities of Practice theory (Wenger, 1998) provides insights into the roles of the Discipline Scholars as they engaged with a number of connected social groupings within the science discipline community. The LTAS – Science project facilitated the formation of emerging *communities of practice*. The consultation workshops, involving every Australian university that delivers a science degree program, formed a meeting point for people with characteristics of a community of practice (Wenger, 1998): sharing a concern or interest in science higher education and its outcomes (domain); engaging in joint activities learning from each other (community) and developing a shared repertoire of resources (practice).
The Discipline Scholars designed the workshops as social learning opportunities based around conversations for learning (*sensu* Haigh, 2006): they were effective in creating connections

across boundaries, for example between science sub-disciplines, stakeholder groups or universities. Workshops were participative activities, designed to develop the SSS to function as a *boundary object* on the national level (Star & Griesemer, 1989, p. 393).

Out of these geographically dispersed *communities of practice* have emerged new national *networks of practice,* to continue conversations on learning standards and to adapt the SSS to sub-disciplinary level (e.g. Chemistry, Biology, Mathematics: see http://www.olt.gov.au/discipline-based-networks). For example, the Agricultural Science discipline community used the Science TLOs as the template for TLOs for bachelor-level degrees in agricultural science (Botwright Acuña, Kelder, Lane, Hannan & Jones, 2013), while the Chemistry Discipline community has mapped their undergraduate degree programs to Chemistry TLOs based upon the Science model (Schultz, Mitchell Crow & O'Brien, 2013).

In February 2012, Associate Deans of Teaching & Learning from universities across Australia met for the first time to discuss the 'why' and 'how' of implementing the Science TLOs. These discussions continue under the auspices of the Australian Council of Deans of Science, which has established a virtual Teaching and Learning Centre (http://www.acds.edu.au/tlcentre/) and hosts annual forums for HE leaders of science education. Thus the SSS continues to function as a *boundary object* within diverse communities and networks of practice. It is being used as a tool for curriculum renewal and for supporting expansive cycles of learning/transformation in curriculum design (Johnson, 2014).

Concluding Comments

The LTAS-Science project was conducted within the context of a new national political agenda for the quality assurance and accreditation of higher education. Its aim was to ensure a discipline 'voice' and influence in that context (ALTC, 2011a; Elson-Green, 2009). The key challenge was to design a project with enduring positive impact upon science educational practice and curriculum across the national university sector despite the uncertainties and complexities inherent in those national policy changes, that have yet to see resolution.

This paper has presented a sociological analysis of the LTAS - Science project, focusing on the key artefact, the Science Standards Statement, and key actors, Discipline Scholars. The project represented a *cycle of expansive learning* that occurred within a historical and cultural context, prompted by contradictions between the then current system for assuring quality of university courses and the standards-based approach foreshadowed by the Federal government. In their *broker* role, the Discipline Scholars catalysed development of the SSS and introduced science educators to standards-related resources and practices.

The Science Standards Statement will continue to function as a *boundary object* within the discipline community. An emerging community of Science educators are using the SSS as a shared artefact for curriculum renewal and proactive development of institutional responses to accreditation and quality assurance requirements. As *boundary object*, the SSS enables a coherent national effort by science educators.

> (The Science Standards Statement has become) a central focus for what is increasingly becoming a groundswell of science curriculum change across the university sector. Some of this would have happened despite the LTAS Project. However, without being able to prove this point, I feel that having the TLOs as a

> focus and a useful reference tool has galvanised activity in this area.. (DS reflection 07/02/12)

Wenger (1998) notes that, while it is not possible to institutionalise a community of practice, it is possible to provide institutional support: the key to success is that its design comes from within, and the practice that results constitutes a response to that design. The LTAS-Science project demonstrates that a well-resourced community-based approach to the challenge of a political imperative for national learning outcome standards, which contradicted aspects of academics' educational practice, can be designed to prompt a *cycle of expansive learning* that resolves contradiction.

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