

# Advancing Science by Enhancing Learning in the Laboratory (ASELL)

## A Project Proposal for the Australian Council of Deans of Science (ACDS)

### *Executive Summary*

ACELL has been very successful in influencing the conduct of undergraduate chemistry laboratory work throughout Australia. A database of chemically and educationally sound experiments has been established, and it continues to grow. The materials provided by the database include all materials needed for the introduction of a selected experiment to a new institution, plus evidence of its influence on student learning. The database serves both to disseminate examples of good educational practice, and provides the materials that allow an institution to undertake objective in-house evaluations of any other experiments. Professional development activities undertaken during and after ACELL workshops, coupled with the student involvement at every stage of the project, have resulted in the formation of a chemistry education community of practice involving academic staff who have never before undertaken any education-related research. In short, the ACELL project has built to a point where genuine cultural change is slowly occurring, and the role laboratory work in learning chemistry is being reconsidered.

The proposal outlined in this document contemplates bringing the ACELL approach to a broader range of scientific disciplines. Experience from ACELL over the previous decade suggests that building a community of practice within a discipline produces a feeling of shared ownership of the processes of change, avoiding the resistance that can occur when change is perceived as being imposed. By making the professional development (rather than the building of the database) the principle aim of an expanded ASELL project, it is anticipated that such communities can be established within each discipline in a much shorter period of time than has been the case in chemistry. Conducting ASELL under the auspices of the ACDS would provide the leadership that can join with communities of practice to accelerate the process of change within each scientific discipline. Initially, this would involve the Associate Deans (Teaching and Learning), or equivalent, taking on the leadership role for ASELL at each institution. Conduct of the project would be the responsibility of an ASELL Board of Directors supervising separate teams for each discipline, so the workload for Associate Deans would not be onerous. Whilst the project should ultimately become self-funding, substantial funding support would be required initially; it is hoped that this might be obtained from the ALTC, the ACDS, and the participating universities.

## **Introduction**

The Advancing Chemistry by Enhancing Learning in the Laboratory (ACELL) project has demonstrably influenced the approach to conduct of the undergraduate chemistry laboratory in universities around Australia. The original project goal of building a database of educationally and chemically sound experiments, including all the materials needed to introduce the activity to a new institution, has been very successful and the database continues to expand. Perhaps more importantly, ACELL has provided professional development experiences that allow chemistry academic staff responsible for teaching in the laboratory environment to engage in curriculum development activities that improve students' learning experiences in a systematic, evidence-based way. ACELL is also working to make the literature of education more accessible for academic staff unfamiliar with its practices and language.

Since ACELL began with a physical chemistry focus in 1999, more than 25% of all chemistry academic staff in Australia have participated in the project at some level. ACELL has earned the respect of the heads of departments around the country, indicated by their willingness to send staff to workshops and to cover some of the costs involved. This critical mass of academic staff, backed by their respective departmental heads and coordinated through ACELL, forms a community of practice that is in a position to help deliver a cultural change in the role of the laboratory environment in learning chemistry. The ACELL Directors have been recognised by the Carrick Institute (as then it was) for their work, both for their influence on student learning and in leading the nation-wide project. This document outlines a proposal to expand upon the success of ACELL by introducing the project methodology to a broader range of scientific disciplines.

In the first instance, the proposed expansion to an ASELL (S = Science) project would be limited to kindred discipline areas of physics and the biological sciences. Evidence from collaborative work with the Carrick Institute-funded *Emerging Opportunities in Physics Education* project suggests that the ACELL-approach is applicable within the discipline of physics, perhaps with some minor modifications. A workshop in biology in which ACELL participated also produced positive indications for the suitability of the project methods for biomolecular experiments; however, project methods will likely need modification to adequately handle activities in areas taking a macro-scale perspective of biology (such as dissections or ecology fieldwork). The ASELL project team would welcome the challenge posed by developing instruments suited to these types of practical scientific investigations.

Expanding from ACELL to a genuinely science-wide and self-sustaining ASELL project is a long-term project which the present ACELL Directors believe is best undertaken under the auspices of the Australian Council of Deans of Science (ACDS). The involvement of individual universities in the project would occur under the supervision of the Associate Deans (Learning and Teaching), or equivalent, at each university. Liaison with professions is anticipated via closely interacting with bodies including the Royal Australian Chemical Institute (RACI), the Australian Institute of Physics (AIP) and the Australian Society for Biochemistry and Molecular Biology (ASBMB).

This document discusses creating an initial 3-year funding application to the Australian Learning and Teaching Committee (ALTC) to establish ASELL. A priority project goal would be to establish a mechanism of project sustainability, or self sufficiency, initially in chemistry but then expanding to other science disciplines. Experience from ACELL suggests that the costs involved in introducing the project to a discipline are larger than those required

to continue once the project is established within a discipline. Consequently, there may be need for further funding support for the goal of self-sufficiency to be achievable across all science disciplines. This document seeks to promote discussion of the proposal amongst the Deans of Science in Australia.

### ***Aims of the Proposed ASELL Project***

The ACELL project has pursued four principal aims: (i) the building of the database of educationally and chemically sound experiments and associated their materials; (ii) the provision of professional development for chemistry academic staff, tailored to the needs of those without prior experience in education-related research; (iii) facilitating the development of a chemistry education community of practice across Australia; and, (iv) undertaking original empirical research relating to learning in the laboratory environment. These aims are listed in the order they were included in ACELL, and over time it was found that the first aim became less prominent as the development of the database materials was used as a vehicle to promote the project's professional development goals. For the proposed ASELL project, this change would be formalised so that the principal project direction concerned professional development, with the database-building activities being incorporated more as a means for pursuing this end. Thus, the proposed aims for an ASELL project are:

- (i) to provide for the professional development of science academic staff by expanding their understanding of issues surrounding student learning in the laboratory. By undertaking a structured and supported development of a single experiment through workshop testing and student feedback phases, staff develop the skills for evaluating and developing other experiments independently using an evidence-based curriculum development approach;
- (ii) to make available, via a public database, materials relating to undergraduate science experiments which are educationally and scientifically sound, having been evaluated by both students and academic staff;
- (iii) to facilitate the development of science education communities of practice within the broader scientific academic community. Discipline-based workshops will initiate the formation of a community of practice within each discipline, whilst the staff from different disciplines within an institution will be able to foster links for a truly science-wide community of practice. It is likely that the Associate Deans (Teaching and Learning) may facilitate this process by bringing together all staff who have been involved ASELL activities from nearby institutions; and,
- (iv) to undertake original research about student engagement, motivation and interest in the specific context of science laboratories. With commonalities of data collection instruments and approaches across the entire field of science, the project will be in a unique position to undertake investigations across disciplines and identify similarities and differences in student learning between disciplines.

The benefits of ASELL will be manifest in three distinct areas, *viz.*, students, academic staff and science faculties. Student learning will be enhanced with more engaging laboratory activities, producing superior learning outcomes. Academic staff benefit from professional development in terms of a better understanding of the educational issues associated with student learning in the laboratory environment specific to their discipline. It is worth noting that University- or even Faculty-wide professional development units generally lack the discipline-specific expertise required to effectively bridge between educational research and teaching in a discipline. The benefit to science Deans is that these improvements will be implemented in a consistent and verifiable / measurable fashion across all participating disciplines. In effect, the project can provide community-led quality assurance.

### ***ASELL Workshop Activities***

ASELL will be conducted within the framework of distinct discipline teams, modelled on the structure that has proven successful in chemistry. Initially, teams would be formed in the areas of chemistry, physics, and the molecular biosciences / biology – whether this last area would be best served with one or two teams would ultimately need to be determined by the relevant discipline stakeholders. Teams could later be added in cognate discipline areas, allowing expansion to cover the entire field of science. Each team will operate semi autonomously within an overarching structure (in other words, within an ASELL franchise framework) thus ensuring that such expansion does not produce an unduly onerous workload.

To achieve the aims of improving undergraduate laboratory learning stated above, ASELL adopts a multifaceted approach. The most tangible aspect involves discipline-specific experiential workshops that provide an accessible entry point, or bridge, into educational concepts within the framework of the discipline. The ASELL workshops include discussion of educational issues, both in abstract (through discussing laboratory learning in general) and concrete (through debriefing of each experiment tested) terms. At these workshops staff and students work together to create an educational evaluation of contributed experiments – an evaluation based in part on the educational description provided prior to the workshop. Outcomes from workshop participation include an improved understanding of educational issues from a student perspective. The workshop also provides for the database potential experiments that have satisfied the third-party testing criterion, and that have been evaluated for scientific and educational soundness. Discipline-specific ASELL workshops will be held at periodic intervals across Australia.

After each workshop, a revised experiment is run in its home institution where ASELL supervises a data collection concerning the students' learning experience using survey instruments developed and validated by ASELL. Assistance in the analysis and interpretation of the student feedback data is provided, allowing the staff member to use the student feedback to further improve the laboratory activity. Continuous professional development is achieved through on-going engagement with the ASELL community via the project website and experiment assessment and evaluation. At this stage, academic staff should have the skills to be able to conduct an educational analysis of all experiments in their laboratory program, identifying strengths and weaknesses in the overall program as well as individual experiments. Such analyses may not need to be as rigorous as a complete ASELL validation would be, but instead can be tailored to suit the purpose of the evaluation. Of course, the community of practice surrounding ASELL continues to provide support.

### ***ASELL Management Structure***

The management and organisation structure envisaged is illustrated in the diagram on page 9 of this document. A Board of Directors consisting of some present ACELL Directors – probably including Professors Mark Buntine and Scott Kable – together with the appointed leader of each of the Discipline Teams is proposed. The Board would also include an academic developer (such as present-ACELL Director Associate Professor Simon Barrie), a representative from the council of Associate Deans (Teaching and Learning), and the ASELL Associate Director who would be employed on the project. This Board of Directors will be responsible for the centrally coordinated activities of ASELL. The Directors for each Discipline Team will have the principal responsibility for selecting academic staff in their discipline area to join their team. Building on the ACELL approach, it is proposed that each Discipline Team would also include an academic developer, who would liaise with the academic developer on the Board.

A secretariat would be established, headed by the ASELL Associate Director, with responsibility for much of the day-to-day work of the Board and the Discipline Teams. The Associate Director would be a full-time level B academic position, and would be assisted by a Project Officer (HEO step 5/6). The Associate Director will ideally have research experience in science education suitable to allow her or him to work semi autonomously on the research activities relating to project aim (iv). This would likely include work developing new instruments and methods suitable for biology activities which take a macro-level or fieldwork approach. It is expected that the Associate Director and the Project Officer will work in close coordination on all aspects of the project implementation. It is envisioned that at any given time they will both be involved simultaneously with multiple workshops.

The secretariat, under the supervision of the Board, would have day-to-day responsibility for tasks including:

- (i) organisational support for Discipline Teams in preparing for and conducting workshops;
- (ii) maintenance and updating of the project website;
- (iii) routine communication with ASELL participants in consultation with the relevant Discipline Team;
- (iv) monitoring the progress of all experiments through the process, including providing individual academics with assistance as required;
- (v) supervision of data collection in line with the Human Research Ethics Committee consent for the project;
- (vi) entry and routine analysis and its return to the relevant academic staff member and discipline Board member; and,
- (vii) coordination of administrative activities, including organisation and planning for Advisory Panel and Board meetings.

Meanwhile, the Board of Directors will retain responsibility for:

- (i) policy development and overall project leadership;
- (ii) reporting to and liaising with relevant stakeholders including the ALTC, ACDS, participating universities, and professional societies;
- (iii) design of the project website;
- (iv) coordinating publication activities; and,
- (v) providing advice and oversight for the activities of the Discipline Teams in each of the core discipline areas.

The ASELL Director for each Discipline, along with their Team, will be responsible for the conduct of the ASELL workshops and related activities in the relevant discipline area. Teams are envisioned to be semi autonomous in terms of specific details relating to the conduct of ASELL workshops and the liaison between ASELL and the specific discipline community. However, key aspects of the overall ASELL methodology and survey instruments are to be maintained. A key driver within the ASELL framework is for the individual disciplines to have a sense of input and ownership of the processes leading to improvements in their discipline. The Discipline Directors are responsible for communication of discipline-specific activities to the Board of Directors.

An ASELL Advisory Committee will be established. The Advisory Committee will provide an external expert perspective on the progress and performance of the project on a continuous basis. The Advisory Committee might include experts in tertiary education, discipline-based experts, a representative of the ACDS, representatives of the aforementioned professional bodies, and potentially collaborators from related international projects.

### ***Role of Associate Deans (Teaching and Learning)***

Coordination of the involvement of academic staff and students from individual universities will be the responsibility of the relevant Associate Dean (Teaching and Learning) from that university. During ACELL, invitations to participate were sent to relevant Heads of School, who were asked to nominate a representative. In so doing, the Head of School was undertaking to pay part of the costs for workshop attendance, and was also asked to agree to making experiment materials (student notes, etc.) available through the project website. With the expansion to several different science disciplines, this role needs to be shifted from individual Schools to their responsible Faculty, likely at the Associate Dean level. For the project to become self-sustaining, the costs of workshop participation for both an academic staff member and a student must be shifted to the participating University. As such, the university representative will need to make provision for costs including travel, accommodation, and food. Finding a student participant could be made the responsibility of the academic staff member delegated to attend the workshop, or undertaken by the Associate Dean. Preparation of workshop materials in the lead-up to the workshop, and coordinating post-workshop data collection, need not involve the Associate Dean unless s/he so wishes.

Another possible activity for the Associate Dean might be coordination of meetings between staff and student participants from different disciplines and / or nearby institutions. In this way, the Associate Dean can help to forge the links needed for the science-wide community of practice (see the yellow links amongst academic staff in the organisation chart). Associate Deans will obviously undertake whatever internal review of project participation that they may wish. They will be responsible for reporting to ASELL on the adoption of, and resultant consequences to the student laboratory learning experience, across the disciplines in their institutions.

The student representatives to the project offer the Associate Deans a previously unavailable resource in terms of obtaining student feedback for their institution. Students who have attended an ASELL workshop will be far more conversant with the aims of laboratory work, both for individual experiments and for semester-long laboratory programs. As such, their feedback could be of much more value than would typically be obtained from only a couple of students. Indeed, should Associate Deans wish, it may be possible for the students to prepare some formal report (for credit) on a laboratory program they undertake in the semester following their workshop participation, to be assessed either by the Associate Dean or in consultation with the ASELL Board. Such a unit could be incorporated as part of a Faculty Talented Students' Program, for example.

Any expansion to ASELL will necessarily involve training and discussion of project methods with the new Discipline Teams. In the proposed timeline below, this training would be undertaken in the lead up to and in conjunction with the first workshop. For the Associate Deans to have a true understanding of the project as a whole, it would also be desirable for them to undertake an orientation activity. This could well involved attending the last session of a workshop and discussions and debriefs on the day following. Such sessions could be run with the first workshop of each discipline, and it would be desirable for each Associate Dean to attend one of these sessions – chosen perhaps on the basis of timetabling, geography, or the Associate Dean's own area of expertise. The ACDS might perhaps consider providing funding for Associate Deans to participate in these orientation activities.

### ***Proposed Project Timeline***

Assuming that the ACDS sees merit in the proposal and the ALTC viewed a funding application favourably, a three-year timeline involving at least two full-scale workshops in each of the three areas can be envisaged. The following assumes a funding decision is known late in 2008, but the timeline can be adjusted with relative ease in semester-long steps.

- Jan `09** Advertise for ASELL Associate Director position  
Invite participation for a Discipline Director in each of the three areas
- Feb/Mar `09** Appoint Associate Director  
Hold initial meeting of Board of Directors  
Form an interim chemistry team to conduct first workshop
- Sem 1 `09** Discipline Directors in areas other than chemistry form their teams  
Plan chemistry workshop for July 2009 holiday period  
Ongoing training of Associate Director drawing on ACELL expertise  
Ongoing training of chemistry team drawing on ACELL expertise
- Jul `09** First Chemistry Workshop  
Train-the-trainers activities for other Discipline Teams  
Associate Dean orientation activities (attend one of the three)  
Formation of chemistry team (previous ACELL members step back)
- Sem 2 `09** Plan physics and biomolecular workshops for end-of-year holiday period  
Begin in-semester data collection in chemistry  
Begin work on new instruments for macro biology activities  
Second meeting of Board of Directors, matching with ACDS AGM
- Dec `09** First Physics Workshop  
Associate Dean orientation activities (attend one of the three)
- Jan/Feb `10** First Biology Workshop (Biomolecular)  
Associate Dean orientation activities (attend one of the three)
- Sem 1 `10** Begin in-semester data collection in physics and biology  
Continue in-semester data collection in chemistry  
Refine new instruments for macro biology activities  
Possibly plan for a mini-workshop to test new instrument between semesters
- Jul `10** Possible mini-workshop for macro biology activities
- Sem 2 `10** Continue in-semester data collection  
Plan for workshops in each discipline over the 2010/11 summer period  
Third meeting of Board of Directors, matching with ACDS AGM
- Dec `10** Second Chemistry Workshop  
Second Physics Workshop
- Jan/Feb `11** Second Biology Workshop (Macro)  
**2011** Ongoing data collection and publication activities

### **ASELL Budget**

The following draft budget represents a first-pass approximation for the cost of running the ASELL project as described for three years. Costs are identified as being funding requests from the ALTC, the ACDS, or participant universities. These estimates would obviously be subject to negotiation and refinement, and should be taken only as indicative suggestions. Leveraging funding from learned societies such as the RACI, AIP and ASBMB would also need to be investigated. Certainly the ACELL experience has shown enthusiastic support from the RACI, and indications of other possible areas of support have been received.

In addition, this proposed budget includes direct costs only, and not indirect costs borne by participating universities, for example in hosting workshops and project staff. In-kind contributions from potential international collaborations are also not considered.

	<b>ALTC/DASR</b>	<b>ACDS</b>	<b>Universities</b>
<b>Personnel (including increments):</b>			
Associate Director (Level B, 1.0 FTE)	315,000		
Project Officer (HEO 5/6, 1.0 FTE)	190,000		
Admin Support (HEO 4, 0.25 FTE)	55,000		
<b>Professional Support:</b>			
Project Management (@\$150/hr)	30,000		
Project Evaluation (@\$150/hr)	15,000		
Project Management Training (Secretariat)	3,000		
Website Development and Maintenance	30,000		
Teaching / Admin Relief for ASELL Directors, including Discipline Team Leaders	30,000		15,000
<b>Activities:</b>			
ASELL workshops			30,000 per workshop
ASELL Directors, Associate Director & Team Members Travel /Meals/ Accommodation (20 people@\$1k p.p. x 2 trips)	40,000		
Advisory Panel Meeting Costs (10 people, 2 meetings @ \$1k p.p. per meeting)	20,000		
ASELL Directors Meetings (with ACDS AGM)		20,000	
Travel / Accommodation for Train-the-Trainers in first year (15 people, 1 meeting @ \$1k p.p.)	15,000		
Associate Deans Orientation			shared costs for A/Deans
<b>Other:</b>			
Office consumables (eg, printing)	15,000		
PCs for A/Dir & PO (@ 3k ea x2)	6,000		
<b>Total:</b>			
<b>Total Budget over 3 years:</b>	<b>\$764,000</b>		<b>15,000 + 30,000 per workshop</b>

