General presentation

Advancing Science and Engineering through Laboratory Learning (ASELL) in Victorian Schools

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Abstract. It is known that a need exists for improved practical skills in students going into VCE. And there is a dearth of interested students who elect to take units in science and maths at VCE. As part of the federal government's Australian Maths and Science Partnerships Program (AMSPP), ASELL (Advancing Science and Engineering through Laboratory Learning) for Schools has been successful in receiving funding to provide professional development to teachers to assist them in improving the quality of teaching and learning in laboratory programs in science. Nationally, ASELL in Schools has development centres in Sydney, Armidale, Adelaide, Perth, and Darwin. Progressing over three years, the authors are forming partnerships with Victorian schools to design, test, and implement a number of focused laboratory-learning activities for use in years 7-10. To accomplish this, several schools were invited to nominate a practical activity that needed either development or improvement. With the assistance of expert scientists and engineers, the ASELL team produced a number of activities that were tested by both students and teachers in a workshop setting. In addition to developing general activities in a variety of STEM fields, the authors have also focused on activities that help students develop inquiry skills.

Introduction

A widely cited 2012 report by the Australian Academy of Science (AAS) showed a disturbing fall in the number of students studying science in years 11 and 12 (Goodrum, Druhan, & Abbs, 2012). To address this fall, the report recommended, among other things, that educators recapture the interest of students in years seven to ten, more professional development opportunities be available for science teachers, and a suite of digital curriculum resources be developed, especially for the 'new' national curriculum. A further paper by Kennedy confirmed the findings of the AAS, noting that those findings are a serious concern (Kennedy, Lyons, & Quinn, 2014). Another national report noted that students themselves have called for increased practical and hands-on activities in the years prior to VCE (Lyons & Quinn, 2010). Teachers recommended that the curriculum needs to be placed in a proper context in order to engage students. The report further recommended that improved links be established between scientists and classrooms, and students be made aware of their options in science-related careers.

This project is about the Victorian contribution to a national education project aimed at improving practical learning for secondary students in years seven to ten. Called Advancing Science and Engineering through Laboratory Learning – ASELL in Schools. Funded by the Australian Maths and Science Partnership Program (Department of Education and Training), the member universities are Deakin, Sydney, La Trobe, Curtin, Adelaide, Flinders, New England, and Charles Darwin (Yeung, Pyke *et al.*, 2011). An additional national partner is the Australian Science Teachers Association.

The key objective of ASELL in Schools is to provide students with a robust, relevant, and interesting laboratory experience that supports their learning of science concepts. The result will be to increase their engagement and interest in science, and hold that interest in the years through VCE and beyond.

How do we do this: by partnerships among various STEM groups:

- University academics
- Teachers and school administrators
- Practicing scientists and engineers
- Science-education associations
- Other education research programs, such as ReMSTEP (Pesina & Carrol, 2014).

These partnerships are being developed across Australia, not just in Victoria. The basic process follows 10 steps:

1. A school is asked by the ASELL team to nominate a practical or lab activity that needs work or development.
2. The school nominates a teacher to work with the ASELL team. This person is called a 'teacher-scholar'
3. The teacher-scholar, after consulting colleagues, nominates an activity for development with the team. The teacher-scholar also identifies where the activity fits within the Victoria state curriculum.
4. Working together, the ASELL team and the teacher-scholar develop a laboratory-learning activity (LLA) that suits the school's needs. The team also consults outside experts (practicing scientists and engineers) for advice to ensure that the science is right and the activity is placed within an appropriate context.
5. Once the activity is developed, the team prepares a set of class notes and procedures for students, teachers, and lab technicians.
6. The LLA is presented to a group of teachers and students at a workshop. The workshop serves as a testing ground for the LLA. Participating teachers and students try out the activity and give feedback to the team on the success of the activity, and where it could be improved.
7. The team further develops the activity, taking into account the feedback obtained from the workshop.
8. Once the activity is ready, and all the documentation is prepared, the LLA is published in an online library of LLA's. The library is in the form of two websites: one for Victoria and also a national website.
9. Several schools implement the LLA in their curriculum.
10. The Schools are re-visited after one year and also two years to determine the activity's effectiveness in their classes.

The whole process also builds up a community of educators whose focus is on improving lab activities for students across all fields of science. A parallel goal of the team is that all LLA's incorporate aspects of educational inquiry. This avoids the trap of producing activities which merely follow a cookbook-like recipe. Incorporating inquiry into the activities is perhaps the most challenging aspect of developing an LLA.

Structure of a workshop

An ASELL-in-Schools workshop runs for a day, hosted by a participating school. We aim for a mix of teacher and students (half each). The ideal workshop has 40-50 attendees. Three lab sessions of about 70 minutes each are conducted. One session presents a well-developed LLA that supports students learning inquiry skills. Teachers and students attend this session. One or two sessions present the newly developed LLA to be tested and evaluated by both teachers and students. An additional activity is given to the students by themselves that supports the area of the curriculum that is the focus of the workshop. Alternatively, the students spend a class period with a practicing scientist or engineer. The visitor presents to the students what the profession is really like and answers questions. At the same time, the teachers meet on their own with the ASELL team to discuss inquiry, representation, and other aspects of good-teaching practice.

Results

The project is about half-way through its life cycle. In this time, the team has developed about a dozen LLA's in varying stages of development and fields of science. Activities presently come from biology, chemistry, physics, earth sciences, and ecology. The activities include:

- Electrochemistry of coupled metals and the basics of batteries
- Rocks and their properties
- Composite materials
- Batteries in series and parallel
- Motion on an inclined plane
- Acid-base titration
- Observations of chemical reactions
- Energy transformations
- Strength of materials in plastic bags
- Adhesives
- Adaptations and habitats
- Mucus and its usefulness.

Conclusion

The team gave 11 workshops to secondary teachers in the Melbourne area over 2015-2016. These workshops tested 12 or more new LLA's. In addition to testing the new laboratory activities, participating teachers gained valuable professional development. Several more (including some outside Melbourne) are planned for 2017 and beyond. Details on the workshops and the LLA's developed can be found at the ASELL-Victoria website: https://blogs.deakin.edu.au/asell-for-schools-vic/asell-for-schools/.

References

Department of Education and Training. Australian Maths and Science Partnerships Program (AMSPP). https://www.education.gov.au/australian-maths-and-science-partnerships-programme-amspp.

Goodrum, D., Druhan, A., & Abbs, J. (2012). *The Status and Quality of Year 11 and 12 Science in Australian Schools*. Canberra: Australian Academy of Science.

Kennedy, J., Lyons, T., & Quinn, F. (2014). The continuing decline of science and mathematics enrolments in Australian high schools. *Teaching Science* **60**(2), 34-46.

Lyons, T., & Quinn, F. (2010). Choosing Science: Understanding the Declines in Senior High School Science Enrolments. UNE: SiMERR Australia.

Pesina, J., & Carrol, G. (2014). Is it time to start reconceptualising maths and science teacher education? *Professional Educator* **13**(5), 8-11.

Yeung, A., Pyke, S.M., Sharma, M.D., Barrie, S.C., Buntine, M.A., Burke Da Silva, K., . . . Lim, K.F. (2011). The Advancing Science by Enhancing Learning in the Laboratory (ASELL) Project: The first Australian multidisciplinary workshop. *International Journal of Innovation in Science and Mathematics Education* **19**(2), 51-72.