

South Australia

Australian Science and Mathematics School (ASMS)

This purpose-built senior secondary school (grades 10 to 12) on the campus of Flinders University was established to innovate in mathematics and science education. Learning activities are interdisciplinary, personalized, authentic and inquiry-based, linking science and mathematics to other areas of study and to real world issues. The school has ICT-rich open flexible learning spaces for groups of different sizes, collaborative relationships between teachers and students, and mixed-age tutor groups and support systems. The students work with an individual learning plan and an electronic portfolio. Students and parents can access a virtual learning environment that students use for group work and to consult plans and materials. The teachers work in teams, and there are extensive activities for professional development and cooperation. The school conducts action-based research to improve its educational practice, and professional learning activities to share knowledge and materials with other practitioners. University collaborations exist with scientists being involved as visiting lecturers and with some students and ASMS teachers undertaking university studies in relevant areas.

Main Focus of Innovation: LEARNERS, TEACHERS, CONTENT, RESOURCES, ORGANISATION

Other keywords: blended/non-formal, learning space, technology-rich

General Information

Name of the ILE: Australian Science and Mathematics School (ASMS)

Location/Address: Flinders University. Sturt Road Bedford Park, South Australia 5042

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ILE submitted by: Kelly Roberts

Rationale

Why do you suggest that it should be included in the project? How does it respond to 21st century learning challenges?

Contemporary economic, environmental, social, cultural and technological conditions are both shaping the lives of individuals and communities in the twenty-first century and transforming their educational needs. The Australian Science and Mathematics School (ASMS), an innovative senior secondary school in South Australia, is an exemplary learning environment embracing the challenge this creates for education.

Although the main purpose of the ASMS was to address the significant decline in student interest and participation in secondary and tertiary mathematics and sciences, its schooling model also addresses the broader educational and learning challenges for the twenty-first century. The extent of the innovation the school has engaged in to achieve these outcomes makes it deserving of inclusion in this project. Key aspects of the ASMS model that address challenges for education in the twenty-first century are mentioned briefly below and described in more detail throughout this document.

The school prepares students for their lives by facilitating their development of the skills and capabilities they will need for:

- lifelong learning (both self-direction and meta-cognition);
- self-reflection;
- successful collaboration;
- innovation and creativity (both ability and confidence to take risks);
- problem solving in a variety of contexts, drawing on interdisciplinary knowledge;
- higher order thinking;
- interaction with others in an interconnected world; and,
- active local, national and global citizenship.

In order to achieve these outcomes for students, the ASMS has created an innovative, inviting and engaging school culture, characterised by a relentless focus on learning. This focus, together with the innovative design of the building itself, have re-defined the role of the teacher from an authority figure engaged in instruction to a colleague engaged in the facilitation of student learning through the creation of authentic, interactive and collaborative learning opportunities.

Importantly, learning at the ASMS is built upon students' prior knowledge, based upon diverse knowledge sources and supported through scaffolding. Although students engage collaboratively in learning activities, the school has adopted a personalised approach to their individual learning and assessment through the provision of a flexible curriculum structure and support for student decision-making.

The ASMS staff have cultivated a professional learning community committed to the school's culture, student learning and the improvement of their professional practice. Teaching activities are de-privatised, as the staff engage collaboratively in their professional practice and learning. Acknowledging that student-teacher relationships are critical to the effectiveness of student learning, staff at the ASMS actively foster relationships with their students through the school's culture and programs. Recent research conducted about the Tutor Program at the ASMS supports the effectiveness of this strategy.

As a result of the school's approach, students are increasingly articulate about their learning, the degree of rigour in the curriculum, their level of engagement with the learning activities, the quality of the relationships in the school community, their learning outcomes and a myriad of other indicators of importance to their lives. The school's culture has engaged its students in science education and in science and technology pathways.

Its success is evidenced by the following:

- 94% of graduating students from the ASMS pursue tertiary education pathways, over 80% of which are in their first or second preference tertiary courses;
- results from the Australian Council of Educational Research ‘School Life’ survey tool conducted each year reveal overall scores of up to 82.5% student agreement with the positive aspects of schooling at the ASMS and 87% satisfaction with teaching; and,
- over 80% of graduating students indicated that the quality of teaching, the opportunity to work collaboratively and be self-directed, acceptance in the school community and experiences in the university environment were positive influences on their learning at the ASMS.

The school’s achievements have been recognised in a number of ways, most recently through the award of the South Australian “SA Great” Education Award 2008.

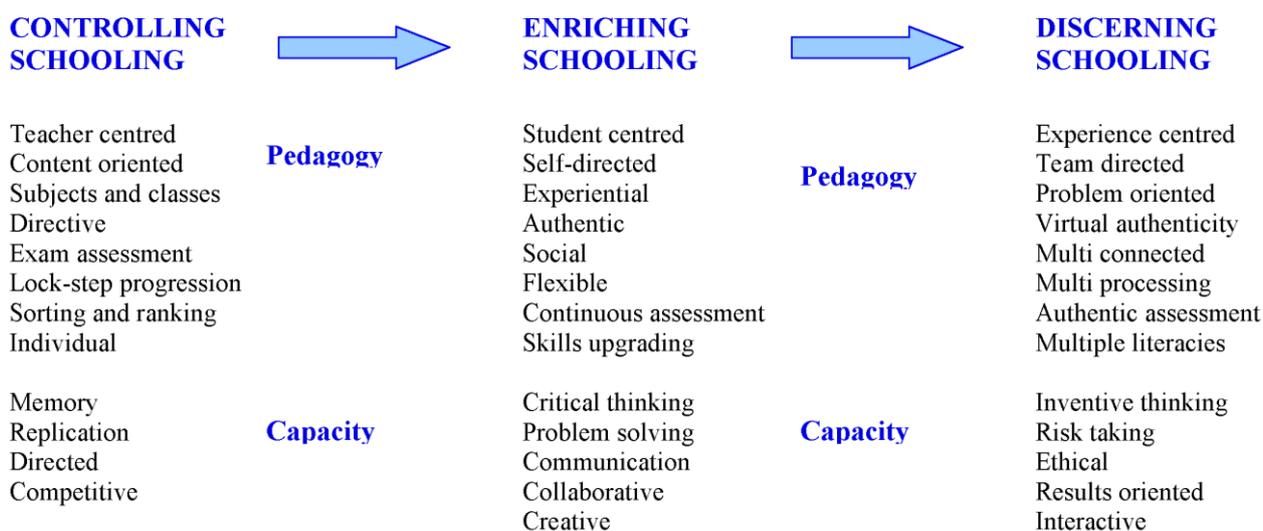
Learning Aims / Intended Learning Outcomes of the ILE

What are the core learning aims and which knowledge, skills or attitudes are to be acquired? (These may include outcomes related to learners’ social, interpersonal, or meta-cognitive development)

Learning at the ASMS is built around a number of important beliefs.

- Learning is enhanced when students possess deep understanding of their preferred approaches to learning (meta-cognition) and are able to self-direct and individually plan their learning.
- Deep understanding is developed through an experiential and inquiry-based, interdisciplinary learning environment.
- The development of learners is enhanced through rigorous intellectual challenge and the opportunity to explore issues in depth.
- Education is most effective when the needs and interests of students shape their curriculum and learning experiences and support their development as independent, life-long learners.
- A thorough understanding of science and mathematics, as well as their interrelationships and applications through innovations within the wider community, is essential.
- Excellence in science and mathematics is demonstrated through its implementation for the general benefit of human endeavour.
- Access to information and communication technologies empowers learning.
- Effective and inclusive learning communities value collaboration, flexibility, respect and interconnectedness with others.
- Perspectives gained through inter-cultural and international communications strengthen learners understanding of themselves, as well as others, and nurture their ability to operate within a global context.

The ASMS builds upon on these foundational beliefs in all their activities and sees its future as a discerning school (see diagram below).



Although students graduate from the school through the certification processes of the South Australian Certificate of Education (SACE), the ASMS does not see learning as being entirely defined by the traditional subject disciplines. Rather, it actively promotes the development of a designated set of capabilities in all of its students. Capabilities are diverse knowledge skills and dispositions that students develop for their roles as citizens, workers and members of local and global communities.

A focus on capabilities is a powerful way to develop balance and connectedness across diverse areas of learning and to promote learning that is transferable to many future areas of life. The ASMS has six declared graduate capabilities that reflect the unique nature of the school and its broad aspirations for its students. Throughout their studies at the ASMS, students are required to demonstrate their capacity to:

- Operate scientifically;
- Operate mathematically;
- Communicate effectively;
- Work both autonomously and collaboratively;
- Demonstrate personal and social enterprise; and,
- Demonstrate critical literacy.

Learners

Which group(s) of learners is it aiming at? Who is eligible to take part? How many learners are there? What are their ages?

The ASMS is a public (government) senior secondary school, offering a comprehensive curriculum for 350 students at Years 10, 11 and 12. Students range in age from 14-19 years. They come from a wide variety of socio-economic and cultural groups from across the state of South Australia, interstate and overseas. Students select the school rather than the school selecting students, based on their interests and passions in science and mathematics. As a result, a diverse range of academic ability is found amongst the student cohort. This ensures equity of access to the innovations of the ASMS, and signals its role as a developer and sponsor of innovative science and mathematics education for all students. It is not a school confined to catering for an elite of gifted students, although gifted students do find substantial and unique opportunities to develop their talents.

Facilitators

Who are the teachers/facilitators? Who are the leaders? What are their professional backgrounds? What are their roles?

There are a total of 41 staff at the ASMS, 32 of which are directly involved in teaching activities. These teaching staff are registered teachers in South Australia with the appropriate qualifications in education and teaching. Many of the staff are involved in advancing their skills and qualifications through Masters and doctoral degrees at Flinders University.

At the ASMS, the role of the teacher has been re-defined to be that of facilitator, coach, mentor and guide-on-the-side. Professional learning is regarded as being the most important work priority for all staff. Their professional learning is the fundamental driver for the development of creative and innovative practice, as well as quality learning outcomes for students. Although this is commonly a significant departure from their experiences in other schools, the staff actively engage with this priority. In order to support their continual development, staff engage collaboratively in reflection, discussion and professional development activities on a daily basis. Furthermore, the staff body is committed to critical self reflection and the freedom to innovate. All staff are encouraged and supported to participate collaboratively in these activities.

The ASMS has developed its leadership through a model of distributive leadership. It is an approach built around Nelson Mandela's belief that leadership is about 'liberating cleverness'.

Collective thought and wisdom shape and re-shape the goals, ambitions, ideas and beliefs about learning. To support this collective task, the ASMS has created a professional learning community, in which staff collaboratively and meaningfully assist each other in their quest to improve teaching approaches and learning outcomes.

This is built on shared vision, critical self-reflection, de-privatization of professional practice, collaborative endeavour, community partnerships and continual professional development.

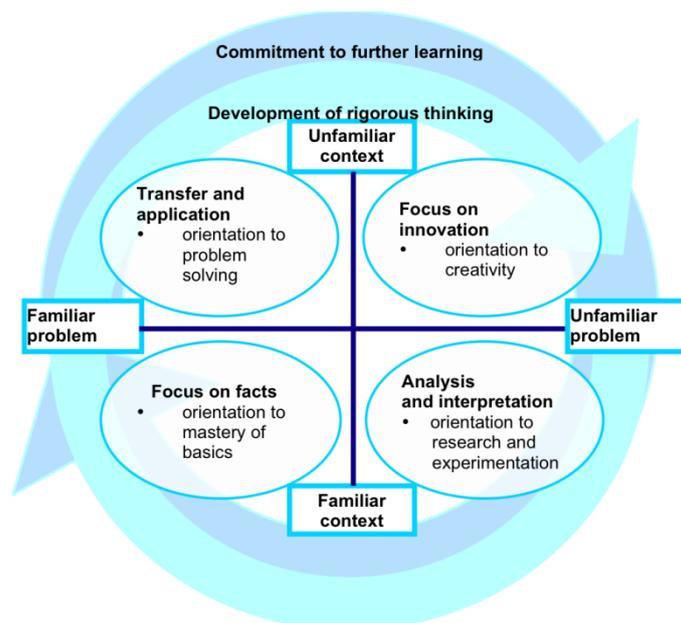
Organization of the ILE

How is learning organised? How do learners and facilitators interact? What kind of pedagogy do they follow? What curriculum is used?

Teaching and learning

Teachers at the ASMS establish strong relationships with their students to ensure they can provide sufficient support for their learning. These relationships allow students and teachers to interact productively and positively. As a visitor in the school, it is impossible not to notice an uncommon level of respect mutually afforded between staff and students. Although students generally engage in collaborative, interactive activities, they are the directors of their own learning. Throughout their enrolment at the school they are encouraged to develop the skills to engage successfully in this task. The student-directed approach is supported by the personalisation of learning through students' individual Personal Learning Plans. These plans allow students to set learning goals, plan, manage and map their learning activities and outcomes. Personalisation of learning is an important and central aspect of teaching and learning strategies at the ASMS. It enables all students to fulfil their potential by engaging them in decisions regarding what, when and how they learn, as well as how they can know and show the quality and extent of their learning.

In addressing the need to provide students with deeper conceptual understanding, the ASMS has developed a model of deep learning (see diagram below) which they use to inform their teaching and learning practices. In this model, students are introduced to concepts through familiar problems and familiar contexts. They then investigate an unfamiliar problem within the familiar context before transferring a familiar problem into an unfamiliar application. Finally, students are challenged with an unfamiliar problem within an unfamiliar context, providing them with the opportunity to develop important skills for future 'knowledge workers', focusing on problem solving through creativity and innovation.



The Tutor Program

The Tutor Program is a central component of the school day, as well as teaching and learning activities at the ASMS. The program's purpose is to maximise student wellbeing.

As a result, the program has a number of aims including to: (a) promote strong student-teacher relationships; (b) create a comfortable social environment; (c) forge partnerships with parents, who are included as collaborators in their child's learning; (d) personalise learning pathways, according to student learning needs and curriculum choices; and, (e) support students to develop the skills and dispositions required to become resilient lifelong learners.

This program is an integral component of the curriculum at the ASMS. Clear connections with the rest of the curriculum have been established through: (a) links to the Central Studies; (b) tutor assistance with the completion of learning tasks; (c) the returning of all assessments via tutors; (d) tutor support and advocacy; and (e) the construction of Personal Learning Plans (PLPs), including regular reflections on learning.

Curriculum

Students in Years 10 and 11 are vertically grouped, participating together in an innovative curriculum. The main component of this curriculum is compulsory for all students and called the Central Studies. Although the key learning areas from the Arts (Design and Technology), Humanities (including English, SOSE and HPE), the Sciences and Mathematics are all addressed in the Central Studies, the structure of this curriculum is interdisciplinary. Instead of being divided by discipline area, the Central Studies are divided into thematic units with a focus on the Sciences and Mathematics. The nine thematic units are run on a two-year cycle and are called 'Mathematics and Abstract Thinking', 'Sustainable Futures', 'The Body in Question', 'A Technological World', 'Communication Systems', 'Towards Nanotechnology', 'Variety of Life', 'The Earth and the Cosmos' and 'Biotechnology'. These themes liberate science and mathematics from being seen as a set of narrow technicalities. Instead, the interdisciplinary structure facilitates deep engagement with the connectedness of knowledge from each of the traditional discipline areas.

Each of the thematic areas has clearly identified concepts, content, skills, processes and perspectives. Furthermore, they fulfil the requirements of the local curriculum standards authority, the South Australian Curriculum Standards and Accountability Framework. The Central Studies enable students to prepare for their present and future lives as thoughtful, active, responsive and committed local, national and global citizens. In the Central Studies, students and staff weave scientific and mathematical logic with cultural, social, historical, legal and ethical perspectives, generating meaningful and connected understandings about the world. Importantly, within the structure of the Central Studies there is ample opportunity for students to make learning choices so that they can plan and direct their own learning, developing critical skills for lifelong learning. Students map their choices through their own Personal Learning Plan, co-constructed with their Tutor and parent within the Tutor Program.

The remainder of the Year 10 and 11 curriculum is made up of three programs: University Studies, Workplace Studies and Supplementary Studies. University Studies is comprised of modules prepared by staff from the Flinders University of South Australia in liaison with ASMS staff. These modules often form an integral part of Central Studies thematic units and include 'Robotics', 'Bioinformatics', 'Cryptography' and 'The Politics of Energy'. These modules range in duration from 10 to 40 hours over weeks or months. Learning outcomes are mapped in the students' individual Personal Learning Plan (within the Tutor Program). Workplace Studies provides students with connections between their learning and the world of work, as well as an opportunity to develop and apply their learning in the workplace and community. Collaboration between students and industry professionals enables their participation in inquiry projects in the workplace and/or community.

These projects are often led by scientists, mathematicians and other experts who provide equipment, techniques and research opportunities. Students can use their learning outcomes from this program towards either their South Australian Certificate of Education or Vocational Education and Training accreditation. The Supplementary Studies are an optional part of the Year 10 and 11 curriculum at the ASMS.

This program enables students to undertake subjects that are not offered by the ASMS through alliances with other schools and education services. Students often undertake study in foreign languages, English as a second language, music, web design and network management.

The curriculum for students in Years 10 and 11 is able to contribute to their development of the school's prescribed graduate capabilities, as well as prepare students for Year 12.

Due to the requirements of both the South Australian Certificate of Education and tertiary entrance, Year 12 students are locked into the standard curriculum and examination requirements as all others in the state. Nonetheless, the teaching and learning practices developed during the previous two years are applied as much as possible to this curriculum. In addition, Year 12 students are able to experience the same learning environment and student-teacher relationships as they have in previous years, enhancing their learning experiences.

Learningo Context

In which context does learning take place? What does the physical learning environment look like? Are community resources used to facilitate learning and how?

The ASMS building is a purpose-built facility designed with maximum flexibility and adaptability to accommodate a wide variety of teaching and learning styles. To transcend the structures that reinforce teacher-centred pedagogical practice and define the traditional power relationship between teacher and student, the building is open plan and learning spaces are designed without obvious orientation. Rather than a series of discrete classrooms, multiple groups of learners work at any one time within each of nine rather large Learning Commons. In these areas, students make use of a variety of workspaces that can be easily manipulated into a multiplicity of structures, depending on particular learning needs.

Studio areas are provided for students to engage in practical work. All areas are connected by a central spine, provided for facilitating social interaction. Indeed, the whole layout is intended to capture the power of adolescent social interaction and to transfer it into the learning environment. The building has been internationally recognised as a model for school design and is included in the OECD Programme on Educational Building Compendium of Exemplary Educational Facilities.

At the ASMS, ICT is integrated into both the learning environment and pedagogical practice. All learning areas within the building are enriched with up-to-date ICT equipment, including computers, presentation screens, equipment for the use of mobile devices such as laptops, and wireless internet facilities. Both teachers and students are encouraged to utilise a variety of digital media in all learning activities, including assessment. This integration allows the ASMS to more successfully meet the needs of their students by: (a) providing the equipment their students need to develop digital literacy; (b) reflecting the students' world outside school and future; and, (c) interrupting traditional teaching and learning practices.

The ASMS benefits greatly from community partnerships. They have a particularly close partnership with the Flinders University given their administrative attachment with, and location on, the Flinders campus.

Together, they share facilities and resources, as well as participate collaboratively in curriculum development and other programs. Scientists, educationalists and other interested staff from the university regularly engage with ASMS staff and students in a variety of student learning and professional development activities.

The ASMS also has partnerships outside the university, locally and globally, with industry, education sites, individual experts and learners in mathematics and science related fields. These partnerships fuel innovation and enrich student learning.

In recognition that students' lives extend beyond school, the ASMS has developed a multi-faceted approach to encouraging strong partnerships between school and families. The Tutor Program provides a direct link with students' families throughout the year through regular, informal contact with the students' Tutor, access to regularly updated information via the school's online Portal, and formal events at the school such as Learning Conversations and information evenings. The online Portal is an internet-based communication bridge linking students, parents and teachers. The Portal provides information for parents about their students' progress, a calendar of planned activities, as well as discussion forum opportunities with teaching staff. Learning Conversations are an important part of the school's personalisation of learning strategy. The conversation occurs between each student, their parent and Tutor. Students present their Personal Learning Plan and then discuss their achievements and plans as a group.

History of ILE

Who initiated it? For what reasons was it started and with what purpose? Have these changed since?

The ASMS was established by the Flinders University of South Australia and South Australian Department of Education and Children's Services and commenced operation in 2003. As explained in response to the previous question, the school's main purpose was to address the crisis in science and mathematics education. Since the late 1970s, interest and participation in science and mathematics education beyond compulsion has been declining in Australia, and across much of the developed world. In order to address this crisis, the school needed to rethink science and mathematics education, and in doing so, discovered that they needed to re-think schooling more generally. As a result, the schooling model at the ASMS is not only an innovative example of science and mathematics education, but an innovative example of schooling in the twenty-first century. The school's aim was to provide opportunities for educators to not only create a comprehensive learning environment for young people, but to create a collaborative and innovative environment for professional learning.

Key platforms of innovation continue to frame the work of the ASMS in the quest to transform senior secondary schooling environments. Together, these platforms enable the school to provide opportunities for deep learning for all students. They are:

1. A focus on the development of a learning environment that is open, interactive, collaborative and rich in information and communication technologies (ICT).
2. Learning programs that are interdisciplinary, authentic, innovative, inquiry-based and personalised to meet the needs of diverse, twenty-first century learners.
3. Professional learning being a top priority to ensure continuing capacity for innovation.

The school remains both committed to their initial purpose and to their innovative culture that drives continual improvement. The ongoing development of the ASMS has presented an opportunity to generate an authentic twenty-first century learning experience for its students. It has provided a chance to have a detailed look at the construction of all elements of senior secondary schooling and to design a schooling experience in touch with the educational needs of the contemporary generation.

Designing and re-designing the pedagogy and predominant approaches to teaching and learning, continues to be the significant, central focus. Creative and innovative solutions continue to evolve.

Funding of the ILE

How is it funded?

The schooling component of the ASMS is funded utilising the standard formula for funding senior secondary schools in the South Australian Government school system. The formula is based on key parameters of class size, teacher workload and the nature of the curriculum. The total funding through this formula for 2009 was \$AUD 1.97million.

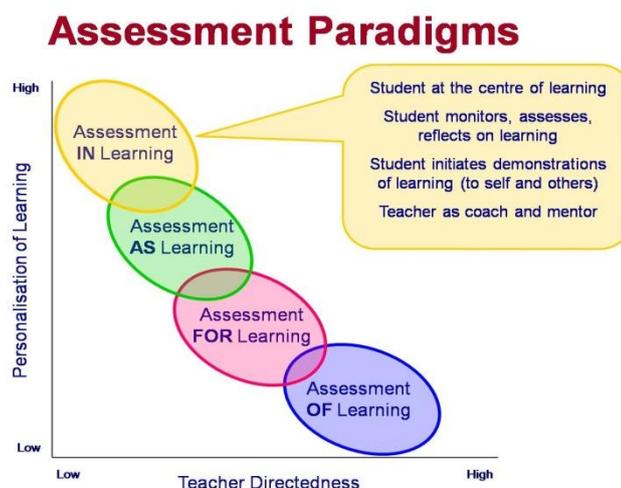
Beyond the funding of the schooling component, \$AUD 1.0million is provided to facilitate the development and research activities, as well as the outreach professional development programs.

The school has always been active in seeking grants for developmental programs beyond its standard remit. In the six years of its operation, grant revenue has been of the order of \$AUD 1.1million.

Learning Outcomes

What are the learning outcomes achieved by the ILE, including academic, social, interpersonal and meta-cognitive outcomes? How is learning assessed?

The ASMS has engaged the paradigm shift in assessment practices to reflect their teaching and learning practices and ensure that assessment is a tool for improving learning rather than examining what has been learnt. The resulting assessment practices allow assessment of deep conceptual understanding. Personalisation of learning is a key characteristic of teaching and learning at the ASMS, however, it brings with it the need for students to take the responsibility for becoming increasingly internally driven learners with skills in self-analysis, self-referencing, self-evaluating and self-correcting. As students move along these pathways, the teacher's role becomes less directive and the student-teacher relationship is a dynamic, focused around the personal learning needs of the student. The generation of feedback about learning, through a range of assessment practices and demonstrations of learning is essential, providing rich data and information to students about the quality and extent of their learning. Students use this information in regular formal and informal reflections on their learning. As teaching and learning becomes more personalised and less teacher directed, the assessment strategies follow suit through four stages – assessment of learning, assessment for learning, assessment as learning, and assessment in learning (see diagram below).



In order to comply with assessment requirements of local educational authorities and university entrance, students at the ASMS are marked in assessment activities according to the requirements of the South Australian Certificate of Education. Average student results and tertiary entrance scores from the ASMS are continually higher than the state average.

Documentation describing or evaluating the ILE

Is there documentation on this learning environment? Is there a website? Films? Research reports or evaluations? Other forms of documentation? (please supply references or links)

The ASMS website is located at www.asms.sa.edu.au. There are a number of documents that may be of interest. These include the ASMS Context Statement 2009, ASMS Annual Report 2008, Occasional Papers 1-7, a number of articles by Davies published in journals and presented at international conferences and other relevant published articles.

Other information you consider to be relevant to describe the ILE

The ASMS has continued to consolidate its reputation locally, nationally and internationally, for the quality and scope of achievements in pedagogy and curriculum development and design. In particular the school has a strong reputation for its role in supporting the professional learning activities of educators and for its work in informing key initiatives of the South Australian Department of Education and Children's Services, including the recent revision of the South Australian Certificate of Education. This has been achieved by focussing Professional Learning activities on:

- the provision of in-service professional development in the new sciences, curriculum development and teaching and learning;
- fostering improvement, innovation and reform in science and mathematics teaching;
- immersing ASMS staff in professional learning as part of their daily work; and,
- developing and implementing evaluation processes that provide quality information about professional development within the ASMS and professional development provided by the ASMS.

Indicative scoping of the professional learning programs is provided through the participation rates in the programs in the 2008 school year, in which over 1100 educators were directly involved. These participants come from all levels of schooling from South Australia itself, from all other Australian states and from a range of international educational jurisdictions.