Directorate for Education
Centre for Educational Research and Innovation (CERI), OECD

Innovative Learning Environments (ILE)

INVENTORY CASE STUDY

Australian Science and Mathematics School (ASMS)

South Australia

This purpose-built senior secondary school (grades 10 to 12) on the campus of Flinders University was established to innovate 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.

This Innovative Learning Environment case study has been prepared specifically for the OECD/ILE project. Research has been undertaken by Susanne Owen, University of South Australia academic researcher and also leader of the South Australian Department for Education and Child Development Innovative Learning Environments project. The project was undertaken following the research guidelines of the OECD/ILE project.

OECD/CERI

Innovative Learning Environments (ILE) Project

Inventory Case Study: Australian Science and Mathematics School (ASMS)

South Australian Education Context

South Australia is one of the six states and two internal territories which comprise the Australian educational context. While the Australian Government has a role in education across the nation, the South Australian education system has primary responsibility for its 600 government preschool, primary and secondary schools, especially in relation to curriculum, funding and accountability. Within the South Australian system, there is a significant focus on lifelong learning and schools meeting economic and social needs, particularly in terms of disadvantaged young people and lifting education participation rates. School leaders and their governing boards and communities also have some degree of autonomy. Innovative educational approaches have been developed by schools to meet the increasingly diverse range of student needs and to build success and create pathways to a broader range of employment and future lifestyle options.

Summary

The Australian Science and Mathematics School (ASMS) for year 10-12 students was established in South Australia in 2003, for the purposes of reconsidering secondary schooling and transforming mathematics and science education to re-ignite student interest and participation in relevant careers. The purpose-built government specialist school (co-located at Flinders University of South Australia), involves a partnership between the South Australian Department of Education and Children's Services and the university. The innovative building design is open, interactive, collaborative and rich in information and communication technologies, with learning programs being interdisciplinary, personalised and inquiry-based. Student-teacher relationships have been redefined, with teachers working as learning facilitators and with action research and collaborative staff professional learning being a key emphasis. Beyond its own staff professional learning commitment, the school also has a role in providing statewide leadership in science and mathematics education, with significant numbers of South Australian, national and international visitors attending workshops and other extended professional learning opportunities.

Aims and Nature and History of the Innovation

The Australian Science and Mathematics School (ASMS) for year 10-12 students, established by the Department of Education and Children's Services in 2003 and located at Flinders University, outlines its aims/charter as follows (ASMS, 2009: 4):

- *responds to current and future interests and needs of its students to establish models of excellence in science and mathematics education;*
- *provides a learning environment of leading edge and enterprise oriented science, mathematics and technology;*

- *provides a learning culture for its students that derives from the learning culture of its staff, which in turn derives from their interaction with university and industry scientists and educators;*
- *is an agency for change and enhancement of science and mathematics education for the state of South Australia and then nationally and internationally;*
- *prepares young people to be creative, critical, informed and motivated contributors responding to professional, personal and social issues; and*
- *increases participation and success of senior secondary students in science, mathematics and related technologies and transforms students' attitudes to science and mathematics as career paths*.

School context

As a purpose-built school, the ASMS synthesises leading edge developments in senior secondary education with a flexible, innovative and ICT-rich building design. While the ASMS includes self-contained facilities such as car parking, a two-level building and two learning commons, a science studio and an Avionics studio on the main campus of the university, some resources are shared. These include the library, cafeteria, gymnasium, sports fields and recreational areas. University lecture theatres, rooms and laboratories are also available on a needs basis. Teachers, research scientists and tertiary educators, particularly in discipline areas such as engineering, mathematics, science and education, have been involved in a collaborative process for the purpose of reshaping science and mathematics curriculum.

The school currently offers a comprehensive curriculum for about 325 students at Years 10, 11 and 12. Representing a diverse range of academic ability and various socio-economic and cultural groups from across South Australia, interstate and overseas, students select the school because of their science and mathematics interests. Enrolment is based on written applications (and sometimes supplementary interviews) in regard to interest and passion in pursuing science and mathematics studies within an integrated curriculum, evidence of aptitude/ability in science and mathematics and demonstrating understanding of personal learning style (ASMS, 2011).

Students transfer into the ASMS at year 10, 11 or 12 levels from approximately 65 schools in South Australian metropolitan, rural and also international locations. About 67% of students are enrolment transfers from government schools, about 27% are from independent and Catholic Schools and 6% of students are from international programs. Overall, about 40% of students are females, with 16% of students being from a non-English speaking background (ASMS-provided statistics). The school's mandate is for the school's enrolment profile to be representative of the state. As indicated by a member of the leadership team:

> *About 20% of students are school card holders... some children come here because it's not working for them in their own school....they're non-attenders or they're low achievers. That's really important if what we are doing here is going to be relevant to other educators…so we can show what we do….Teachers, they'll look to see whether it will work in their context.*

Supporting student learning are the 34 full time equivalent teaching staff and 9 full time equivalent non-teaching staff, with a Principal, Deputy Principal and two Assistant Principals providing leadership. All qualified staff members have an active teaching role and each person is affiliated with Flinders University. The staff commitment to professional learning is evident in that over 40% of teachers have additional post-graduate qualifications, with many others undertaking further study (ASMS-provided statistics). The professional staff works closely with the Flinders University School of Education, providing mentoring for student teacher practicums and delivering a third year unit in the Bachelor of Education.

Origins and Development of the ILE

Rethinking secondary schooling and re-envisaging secondary school science and mathematics and building design to more effectively support learning underpin the establishment of the Australian Science and Mathematics School.

The origins of the school can be traced to the late 1990s. During restructuring of the Faculty of Science and Engineering to allow the new sciences to drive the program, Professor John Rice (research director at Flinders Institute for Research Science and Technology at Flinders University), indicated that a specialist secondary school was also needed because: 'Science now focuses on things like IT, biotechnology and nanotechnology, and it's important to have a school whose role is to foster and promote these new sciences among students and staff' (Larkin, 2001).

The department Chief Executive at that time, Mr Geoff Spring, supported the idea of a specialist secondary school and indicated a major purpose of the ASMS being about ensuring a 'new vision of careers that involves mathematics, science and technology and to design and develop new curriculum'. He also highlighted additional purposes ' ….(to) establish new relationships with scientists, university staff and industry' and 'transformation of the way in which the fundamentals of science and technology are viewed in the community, linking them to both the new sciences and to a culture of innovation and entrepreneurship' (Larkin, 2001). Additionally, a significant role for the ASMS was 'to engage teachers across our system with innovative curriculum and pedagogy and to enhance professional development for all mathematics and science teachers' (Larkin, 2001).

The initial ASMS focus on a new vision of science, re-engaging students and teachers and the professional development is highlighted in an interview with a Flinders University academic who was involved in the early days of the school:

> *It goes back to the days of John Rice...He was very much driven by the lack of people coming in to the tertiary sector to science..He could see that it was too late to be thinking of that in the first year of university..it had to happen much earlier than that..So this initiative was driven by a number of people from a number of perspectives. But certainly there was plenty of evidence to show .concern about the declining numbers..also relooking at engaging kids in more interesting science and mathematics but really rethinking the whole of secondary schooling and how it was structured..That's why the building was designed in the way it was...It's about looking at learning from the perspective of how we learn most effectively and I guess it was a really strong focus on we're not going to be successful at this without really engaging the teachers as learners as well ..So there was quite an explicit focus on that as being critical to achieving the vision of the school....*

Essentially the initial notion was about the school 'being a Centre of Excellence and it had a lot of radical ideas' (Principal), with the building designed to capture this transformative role (Figure 1).

Figure 1: ASMS entrance

An Interim Governing Board was initially established with Flinders University and departmental representation. The alignment of architectural design concepts and evidence-based pedagogical theory and practices was a high priority, with the ASMS focused on educational principles of self-learning, inquiry and collegial work. An active research process of visiting innovative maths and science educational sites in the United States, Europe and England was undertaken. As the project design director indicated at the time:

> *We are looking at a philosophical approach to the school's design which reflects the way maths and science concepts are developed and delivered to the students ie concepts provide a framework for the initiation of the learning and discovery process…We are trying to align how students and teachers will operate in the learning process with the way they will engage with the building* (Larkin, 2001).

The importance of joint research involving overseas travel and ongoing conversations by educationalists and building designers was fundamental to the success of the overall establishment process. This is supported by comments from a member of the inaugural leadership team:

The architects started travelling with the educationalists….and when they came back they continued to have that conversation about the sort of space that would be supporting the teaching….When you go into the studios here it's based around collaborative student work (see Figure 2).

Figure 2: ASMS Studio

The school opened in 2003 with 165 students in year 10 and 11 and with year 12 students enrolling from 2004. During those initial years, the total student enrolment reached 260 (ASMS Annual Report, 2004). Classes were initially conducted in Flinders University buildings while some aspects of the new facilities were finalised. During the years from 2005 – 2009, year 10-12 student enrolments stabilised at between about 260 and 300 students (ASMS Annual Reports 2005; 2006; 2007; 2008; 2009). The school has a current enrolment of 325 (ASMS-provided statistics).

The early establishment phase involving a partnership between Flinders University and the South Australian education system was underpinned by a formalised agreement. The formal links related to facilities use but were also about connections between university and ASMS staff and collaborative development of teaching and learning materials and curriculum. Curriculum aspects included electives (referred to as University Studies) which were initially offered by the academics with ASMS staff participating in the sessions. However, the relationship became more of a collaborative partnership over time, with a university academic recognising in regard to a recent partnerships review that 'now it's a more sophisticated relationship as equal partners'.

This notion of constantly reviewing, questioning and updating the school's directions and achievements and continuing to be innovative has occurred with the support of a relatively stable leadership team. As indicated by an academic with early association with the school:

> *I'm impressed by the constant drive for improvement….*(the leadership's) *continual looking for how we can do things differently...What sciences are we engaging with?...There is a strong focus on learning from students...It hasn't been all smooth sailing with every student...Three years ago now they* (ASMS) *were still at the cutting edge of science and mathematics education... and that was 5-6 years into the set up of the school.*

Structural Patterns: Characteristics of the Learning Environment

Various structural patterns and characteristics of the innovative learning environment emerged in the research observations, surveys, documentation checks and focus groups interviews. These include the innovative educational platform, ICT-rich flexible learning spaces, collaborative relationships, tutor group and support systems, partnerships with external providers and commitment to ongoing professional learning. Details will now be outlined.

Innovative Educational Platform

A significant shift from traditional educational models was highly evident in the ASMS innovative context, with controlled, teacher-directed and self-directed and student-centred schooling being progressively replaced by an experience-centred and team directed model. As indicated in Figure 3, the ASMS sees its future as Discerning Schooling. This is a model which focuses on problem-oriented, multi-connected pedagogy involving multiple literacies and authentic assessment. Moving beyond replication and competition, the approach incorporates building capacities of critical thinking and collaboration, as well as inventive thinking, risk taking, and being ethical, interactive and results oriented.

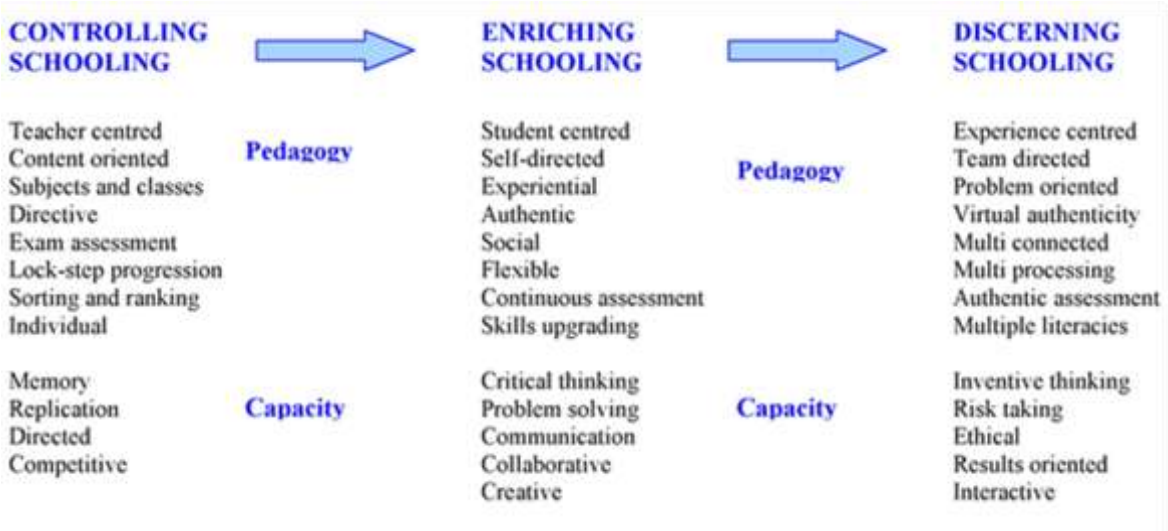

Figure 3: Discerning Schooling

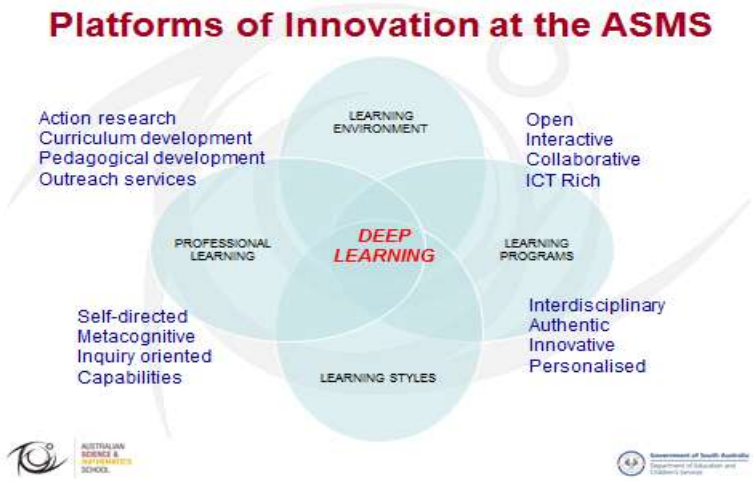

Figure 4 captures the four specific aspects of the ASMS Platforms of Innovation:

- Learning environment (open, interactive, collaborative, ICT-rich)
- Learning program (inter-disciplinary, authentic, innovative, personalised)
- Learning styles (self-directed, metacognitive, inquiry-oriented, capabilities)
- Professional learning (action research, curriculum development, pedagogical development, outreach services).

Figure 4: ASMS Innovative Platform

Aligned with the Discerning Schooling learning model and the school's Platforms of Innovation, various components and principles comprise the ASMS learning program (ASMS, 2011b).

- *New Sciences:* ensuring emerging areas of science such as nanotechnology, aquaculture, biotechnology, photonics, genomics, polymer science, robotics and communication technologies are incorporated into school curriculum.
- *Inquiry Learning:* ensuring students engage in deep study through group and personal projects of major significance, often utilising problem based and inquiry based learning approaches.
- *Interdisciplinary Curriculum:* building programs with a focus on scientific and mathematical processes in ways that are closely linked with learning from all areas of study in real world contexts.
- *Standards of Significance:* providing a systematic approach to allow students to meet school, state-wide, national and international educational standards.
- *Authentic Experience:* allowing students to study real world ideas, problems and issues and to make connections with their learning that are meaningful to them in their present and possible future life circumstances.
- *Engagement and Retention:* providing an impetus that increases participation and success of senior secondary students in science, mathematics and related technologies and transforms students' attitudes to science and mathematics as career paths.

Flexible Learning Space & ICT

Based on the educational model for Discerning Schooling, ASMS Platforms of Innovation and key principles of student-focused and interconnected teaching and learning, the ASMS building was designed to 'specifically use space and place as a learning tool' (ASMS, 2002).

Beyond the functional and philosophical aspects of providing an educational work environment, students, teachers and visitors who enter the foyer and learning spaces are immediately impressed by the flexibility, and the sense of openness and light. The building provides a range of learning settings for variously-sized groups and configurations, with open plan teacher preparation work areas also included. Traditional classrooms are replaced by eleven 'learning commons' which accommodate up to 50 students (Figure 5) and eleven 'studios' (see Figure 2). There are seminar and meetings rooms, student and staff social areas and central common spaces.

Figure 5: Learning Commons

The eleven specialised studios, accessible from the learning commons, provide support for practical and research work related to mathematics, multimedia, physical sciences, applied technology, presentation/performance, environmental sciences, life sciences and human performance. In addition, student-centred spaces for collaborative and inquiry-based learning are a key emphasis, with each student having a home-based personal study desk and locker located in a designated tutor group meeting area in one of the learning commons. Students move throughout a range of areas within the school, the university campus and local community dependent on the particular study program needs. There student area has couches for student relaxation. A key feature of the building design is that the Learning Commons areas are deprivatised, with staff work areas being located adjacent to and visible from the learning commons.

The openness and flexibility of the building design and its purposefulness in developing a learning community is described by a member of the leadership team as follows:

> *..there was very much that culture of a whole school learning environment...and that would be reflected in the space...The teacher offices being so open and accessible ..to be able to easily observe each other's teaching*. (it's about) *.the deprivatisation of teaching...The community where people worked together to improve learning outcomes for students was a very strong driver...The whole concept of learning commons..And to move between those spaces as they needed to...and between those learning commons and the studios....there's glass. Teachers can be moving between those spaces and still have that duty of care responsibility...Also spaces where you have windows that overlook the studios and the learning commons..open up that line of sight...So the whole thing is really open so that everyone feels a sense of belonging to a community where you focus on learning...And people certainly comment on that….You walk in the front door and you don't walk into a foyer, you walk into a class...they get that buzz of purposeful learning…The light fills the space and it's light to work in...The door opens to the outside to let students move in and outside.*

Students and teachers also support the openness of the building design. This is reflected in student comments as follows:

….. A really good thing is the environment….having such open space…There's windows everywhere....here it's so free it makes you feel better (year 12 student) (Figure 6).

..there are little areas….it's nice that they have couches' (year 12 student)

Figure 6: Student area with windows

'There is no door to the office so you can go to the teacher anytime' (year 10/11 student).

Figure 7 depicts one of the staff open office areas.

Figure 7: Staff open office

The staff is also positive about their office work spaces and the professional collegiality and learning opportunities provided, as one teacher indicates:

The way the school is designed, with the work spaces, it determines that we wouldn't have any faculties...geography faculties or whatever. We actually have people from across faculties in most work spaces and some of the SSOs (School Services Officers) *are in those spaces as well...That really works fantastically...because of the level of sharing that happens....It happens in our work spaces* (teacher).

Another key feature in the design of the school which was clearly evident in the observations conducted as part of the research was the abundance of Information and Communications Technology facilities (ICT) and their spread throughout the open space learning environment

(Figure 8). ICT facilities include desktop computers on mobile trolleys being available throughout all of the learning commons and studios, a grid of floor-plates for plug-in power and networks and a wireless environment for laptops. Over 80% of students bring their own laptops and the ASMS makes provision for those students wishing to access a laptop at school or at home.

Figure 8: Learning commons with ICT

In an interview conducted with the e-Learning Coordinator he explained that the ASMS curriculum is available online in the virtual classrooms, including the inquiry programs for the semester, assessment tasks and rubrics, and many resources for students to use in their learning. Designed by the teachers, these resources are available to both students and parents, for old scholars and sometimes for teachers from other schools who are involved in the ASMS professional learning programs.

The ASMS innovative virtual environment provides 24/7 access to the learning community and incorporates three inter-related components: content management for collaborative work such as discussion boards and blogs; learner management where the curriculum is matched against leaning goals and access to learning resources including text, pictures and video and student management in which departmental data is enhanced with anecdotal and grade data. The virtual classroom means that every learning area topic and student group has an area for materials such as learning modules, assessment plans and learning goals, resources and wiki blog discussions. Parents can also access this area, view their child's attendance and assessment records and communicate electronically with the relevant teachers. Class manager for timetabling and attendance records is also available for record keeping and for enhancing teacher/parent/student communications and building relationships.

Collaborative Relationships

Collaborative relationships and rich interactions are key aspects of the ASMS environment and this was very evident in the classroom observations and in focus group interviews. Parents and students indicated that, apart from the maths/science specialisation, challenging work and increased preparation for future related career directions, the opportunity for improved teacher-student relationships was a key reason for transferring into the ASMS from other schooling contexts.

In fact, students and also parents viewed collaborative relationships as a significant difference from other educational environments. Positive student-teacher friendships were particularly highlighted in focus groups, with comments such as: ' they're more like a friend than a teacher' (parent) and, 'I'd go and sit with this teacher and we'd talk about the lesson….it was more like a friendship than a teacher because I actually didn't have her for any classes…and ended up being friends with her' (year 12 student).

Many students in focus groups also believed that the closer student-teacher relationship was supported at the ASMS by the casual dress code (rather than wearing of a school uniform) and the use of first names for teachers: 'using first names, you seem to get on with the teachers more…it feels a lot more casual' (year 12 student).

Teachers' listening skills were particularly praised by students with comments including: 'At other schools they say you're just a kid….Here it's more open ...if you've got issues tell them' (year 12 student); 'if teachers are going on a bit you can tell them' (year 10/11); and 'everyone is so nice here… you can go and talk to them…and say this is what is happening and they'll go and try and figure things out' (year 12 student).

An academic who had been closely involved with the school commented at interview that 'student voice is highly valued'.

Further evidence cited which reflects positive student-teacher relationships is the frequent visitation to the school of former students after their departure: 'Even after students have left the school… they make contact and students talk about the relevance to university and the value that they place on materials and the educational experiences they've had here' (teacher).

Supporting Robert's (2010) research on the overall positive interrelationships and nurturing culture of the ASMS environment, during focus group interviews, students consistently talked about the social atmosphere of the school and the 'ability to interact socially with everyone' (year 12 student). Students also commented on the lack of bullying and acceptance of difference in remarks such as 'there's pretty much no bullying here so you feel safer here' (year 10/11 student); and, 'it's a very unique environment…everyone here is like-minded…no one judges you…You're not judged because you're different…You're accepted' (year 10/11 student).

A teacher also remarked positively about student acceptance of differences among their peers and contrasted this to other school situations as reflected in the following specific example:

> *We* (teachers) *were sitting in our office and looking across .. and there was a Greek boy playing a card game. And there were two boys that would have been called jocks...with two boys who were like the computer gamers and there was one boy with Aspergers ...And the boys were all sitting down playing cards* (with him)...*In other schools...he'd be ostracised.*

Beyond the social aspects of the positive multi-age student-student and student-teacher relationships, many students highlighted the benefits in terms of improved learning, with representative comments being 'everyone's accepted...everyone's here to learn...It's a really supportive environment...You can go to any other teacher...you get that individual 1:1 ..you want to learn more' and 'learning (is) so much more enjoyable..and it's something you look forward to, coming to school'.

Reinforcing the positive relationships culture of the ASMS, a student feedback survey indicated highly positive responses from students regarding developing democratic relationships, building a community of learners, and negotiating learning.

Tutor Group and Support Systems

A key part of the collaborative environment is the ASMS Tutor Group Program, with each student being a member of the same multi-years Tutor group for the duration of their time at the school. The Tutor Group meets daily for a 40 minute period of time. A key role for the Tutor Group is to 'ensure that students feel a sense of belonging within the school' and to 'provide care and guidance through strong student-teacher relationships' (ASMS, 2009:8). Tutors build a relationship with each student in their group over several years, tracking and helping evaluate student achievements and progress. They are also a source of advocacy and provide support for students in completing learning tasks and in making links to the Central Studies curriculum. Tutors also help students to develop a Personal Learning Plan and to write reflections which link to the E-portfolio, with the learning plan ensuring their needs are met 'so that personal interests and experiences in science and mathematics are developed in the context of a comprehensive education' (Oliver & Davies, 2004).

During an observed Tutor Group session involving fifteen students from years 10-12, individualised support time was the key activity occurring, with other students continuing to work in small groups or alone with other school study aspects. Administration issues, returning assignments from a range of teachers, mathematics/science concepts tutoring, career discussions and computer technical support, were the main focus aspects for the individualised student-teacher interactions.

The value of the Tutor Group program is clearly indicated by a member of the leadership team, with her comments being:

> *..the whole tutor group program that's been set up...That 15 kids that you have with you for three years...you get to know them…You are their main advocate but you are also the main point of call for other staff to come to find out about that student... And you monitor ...you meet with them every day for 40 minutes..You talk about how they're making the adjustments and that conversation continues for three years….It's very unique...it's something that many schools who've visited us have really latched onto and taken back….They've liked the vertical grouping, they've liked the connection...and the program that goes with it.*

Students commented on the value of the teacher-student relationships in Tutor Group: 'You've got this relationship with them….you know that they're a teacher but you also have a different relationship with them...here at this school. They're your teacher but if you need support with maths...that's what Tutor Group is good for' (year 12 student).

Parents were also positive about the value of the multi-age Tutor group with a representative comment being: 'you've got representatives of all the years who interact...they're not divided here'.

The Tutor Group teacher role is particularly significant in supporting newly-enrolled students to settle into the ASMS environment. The ASMS learning environment is considerably different from most of the schools which students have attended so induction involves various opportunities. These include open night, an observation day with a buddy prior to submitting an enrolment application, interview opportunity and end of year onsite transition day. A school leader indicated that, given the significant change from previous high school experiences, there was a period of adjustment required. Seeking to research and improve this issue, one of the school's Action Research projects (which are led by individuals and groups of staff), became focused on student retention. The teacher presented the research findings to staff and through a structured discussion, the issues were raised and improvements generated including the development of an immersion process. As a result, almost 100% retention occurred in 2011 due to the school making improvements to the transition program and including

additional preparatory observation days with buddies and also increasing the support provided by the Tutor:

> *We changed our transition support to address some of the really challenging aspects of coming to the ASMS...and that's been very successful...But there are still some students who struggle to hang in there...We see that as being a very important part of the environment of the school....We're here to support them to adapt to working in this environment...We don't talk about lots of rules….it's around when something is not working with the students it's important to help them*.

Another important part of the learning process which occurs within the Tutor Group context is that several times a year, students, parents and Tutor Group teachers meet together and the student takes responsibility for leading an assessment learning conversation. Students are supported in their preparations for the 20 minute reflective conversation by their Tutors who assist them in gathering information about their progress towards learning goals, including the use of assessment results. These Learning Conversations replace the more traditionally issued written reports and are also assessed as part of the requirements of completion of the South Australian Certificate of Education.

The value of the learning conversation is outlined by a teacher:

> *…The learning conversations that we have...a real triangulation with the students taking the initiative and sharing with parents their learning portfolios and PLP* (personal learning plans)..*And most of those conversations are really rich. And follow up ..this often happens in the Tutor Group program of 40 minutes a day and that integration which is there.*

Partnerships with External Stakeholders

Beyond positive internal relationships, collaborative partnerships with Flinders University, relevant South Australian industries, local government and various other national and international contexts have been of fundamental importance in the initial establishment and ongoing sustainability of the ASMS innovative learning environment.

Fuelled initially by the joint Flinders University/departmental vision of transformative change in maths/science secondary schooling and underpinned by a Memorandum of Understanding, the collaborative partnership during the establishment period involved various aspects. These included curriculum development, facilities sharing, student enrichment opportunities within the elective subject (referred to in the school as University Studies) and professional development relevant to the new sciences and associated pedagogy.

In terms of University Studies, these interest-based topics provided students with the opportunity to follow up on a particular area developed collaboratively by an academic and ASMS teacher. These sessions provide extension to the Central Studies curriculum. As one academic indicated: 'The University Studies model was a really good model….And how the teachers and the students were engaging with the academics....it worked out to be very enriching....and lots of that's been absorbed into the curriculum'. Specifically, as outlined by a member of the ASMS leadership team, the university academics were mentoring the staff in university studies and ASMS teachers 'would eventually take over running that themselves....taking it into central studies'.

However, over time the ASMS/Flinders University relationship has changed with the ASMS staff increasingly leading the University Studies topics themselves and with a formal review of the Memorandum of Understanding occurring in 2009. During the lengthy review process, the strength of the partnership was evident because some academics and ASMS staff continued to work together. In particular academics were continuing to offer professional learning for South Australian maths/science teachers and national and international visitors because 'they're passionate about science and maths ... they've been getting involved in their own time'.

A new ASMS/Flinders University Memorandum of Understanding has now been established which was described by an academic leader as reflecting a more equal relationship as a result of '..constantly questioning what the relationship's about...As the school has matured over that time....(it) has allowed the relationship to move forward'. The school and the university are now collaborating in joint ventures for professional development of teachers and exploring research opportunities to inform both partners. In particular, the ASMS and the School of Education have begun formal research about supporting self-directed learners. The Science 21 Unit and the ASMS are also collaborating in relevant teacher professional development activities.

Professional learning led by the ASMS, with some support from Flinders University has continued to be a significant part of the ASMS role. School records produced annually indicate that since 2004, thousands of South Australian and other Australian teachers from metropolitan and country locations have visited the ASMS from hundreds of schools each year for single or multiple day professional learning sessions on a range of topics. These topics include metacognition, pedagogical practices to engage students, e-portfolios, skilling teachers in emerging science areas of biotechnology and nanotechnology, interdisciplinary curriculum, leading edge science enquiry and educational leadership (ASMS, 2004; 2005; 2006; 2007; 2008; 2009). For example, 125 teachers were involved in a series of sessions over five days regarding Advanced Technology materials and science approaches including in relation to biotechnology and nanotechnology. Over 800 educators have worked alongside ASMS staff over two or three days in the Professional Practice program. The ASMS has also worked with teachers from small primary and secondary schools in country regions to support professional learning and inquiry-based science approaches (ASMS, 2011a). Other professional learning aspects have included work with South Australian and Australian governments in mathematics and science curriculum development and quality teacher programs, as well as co-presenting at various relevant national and state subject association conferences (ASMS, 2004; 2005; 2006; 2007; 2008; 2009).

Primary, middle school and secondary school staff are among the visitors and onsite professional learning and visitations are supported by making resources available on the ASMS website:

> *..not only do we share our materials but we also share our knowledge and experience that we've had in developing curriculum along the same lines...and the knowledge around the emerging sciences....What we're doing here is stuff that teachers in other schools know about...sharing materials through professional learning programs and some of those materials are available on our website* (school leader).

Beyond the Australian context, the ASMS has developed a significant international profile, including staff presenting at international conferences, international visitors attending for professional learning sessions and extended visitations for international educators. Within the International Science Fair (initiated by the ASMS in 2004 and now including a network of schools from the USA, Canada, Korea, Japan, Singapore and others), students and staff have also been involved in problem-solving activities, with the ASMS staff being influential in promoting additional aspects to these events. As a school leader indicated: 'Now we run a professional learning component to the Science Fair'.

Another aspect of professional learning which still continues to grow in partnership with Flinders University is the role of the ASMS in conducting topics from undergraduate teaching programs. Undergraduate teachers are involved in structured classroom observations which are followed by focused debriefing sessions which are concentrated on identifying pedagogical content knowledge.

Other collaborative partnerships which were highlighted beyond the Flinders University and school professional learning context involved relationships with scientists, government agencies and local councils.

Commitment to Ongoing Professional Learning

Given the ASMS leadership of innovative science and mathematics teaching and learning, improving student engagement and building career pathways into science, mathematics and technology, there has been an ongoing commitment by the school leaders and staff to professional learning. A key message from focus group sessions with teachers, school leaders and academics was about the importance placed on school staff's professional learning. This includes that occurring informally through workspace co-location and in the staff room; through to each staff member developing annual Individual Professional Development (IPD) plans; involvement in action research work; gathering feedback on professional practice to determine professional learning directions and group assessment of student learning against standards and other team-based activities. The staff document their Individual Professional Development Plans, incorporating goals for improving pedagogical content knowledge and Action Research linked to the strategic directions of the school. They write regular progress reports, sharing their plans and progress reports within their IPD teams.

As indicated by a member of the leadership team:

> *We set up a professional development community based around teaching and non teaching staff..and they develop their professional learning plans for the year...There's four goals that the staff are asked to plan towards...linked to the national professional standards*...(There's an) *..expectation that teachers will collect evidence of their professional learning and the impact on student learning....Another goal is around action research....practitioner research and looking at making that improvement or change in an area of interest linked to something they can have influence on...and they plan for that...We now have a professional practice development...where they have the chance as individuals to reflect on that with a line manager if you like..So it's kept separate from their professional learning*

Staff room discussion and co-location of interdisciplinary teams in work spaces are other key strategies for building ongoing professional conversations as indicated in the following comments from teachers:

> *In the staff room, we actually do talk about learning and areas of expertise and I've learned more about science in the last few years than I did in all my previous schools...and it's really stimulating.*

> *We actually had people from across disciplines in those work spaces…Sharing happens in the staff room, teaching teams, central studies, and work spaces*.

Formalised staff professional learning, underpinned by the distributive leadership model developed by the ASMS over the past two years, occurs within scheduled weekly meeting sessions when students have early dismissal. The distributive leadership model is indicated in Figure 9 and 10.

Figure 9 represents an organic model of the way that people work together in the school to learn and innovate. The organization, that is, the students, staff and the school itself, learns through the collegial work of the teams that surround the learning and innovation space. As a result of this learning, the school contributes leadership (contributive leadership) to the wider context of the educational community through the knowledge it creates and shares with others outside of the school. Through its contributive leadership, the ASMS realizes its charter, that is, to transform science and mathematics education.

Figure 10 shows how the ideas that are generated by the collegial teamwork flow throughout the organization and to the wider context beyond the school. The teams are formed because of the work that needs to be done and the learning that is required to support that. Leadership arises from the knowledge and expertise of the individuals rather than their role and position. The work of the teams is interdependent rather than guided by strict roles and functions. This exemplifies the dynamic and flexible way that people work and learn together enabling the organization to respond to change, resulting in learning and innovation.

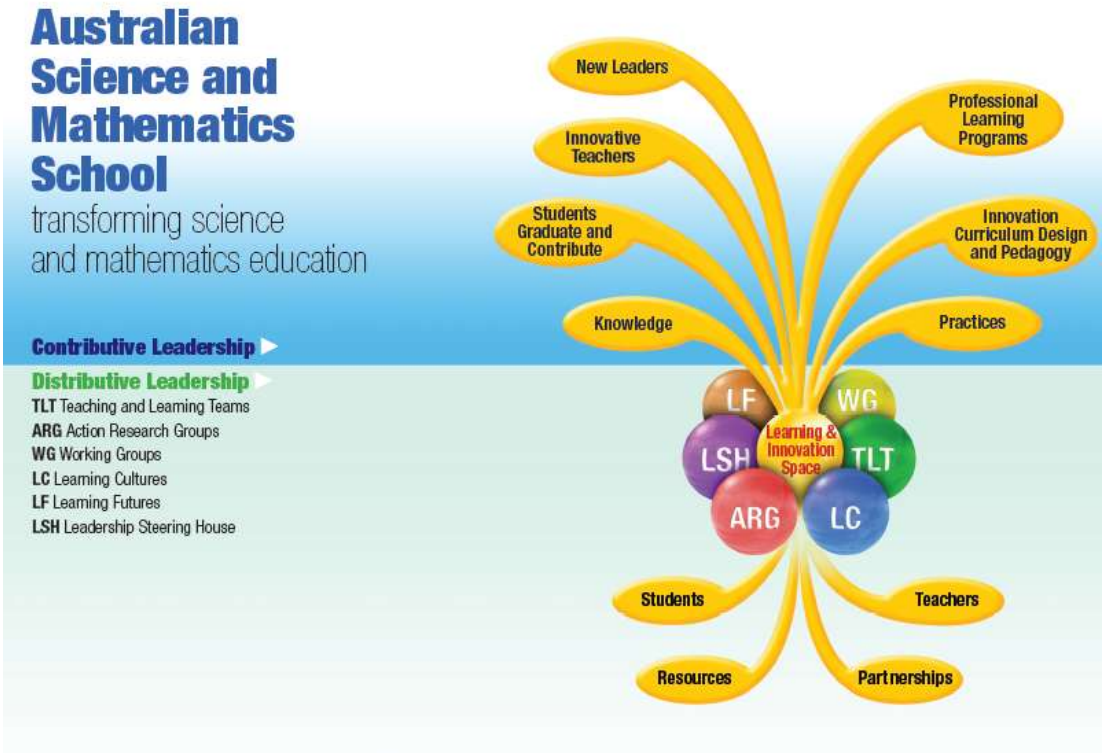

Figure 9: ASMS Distributive and Contributive Leadership Model 2011

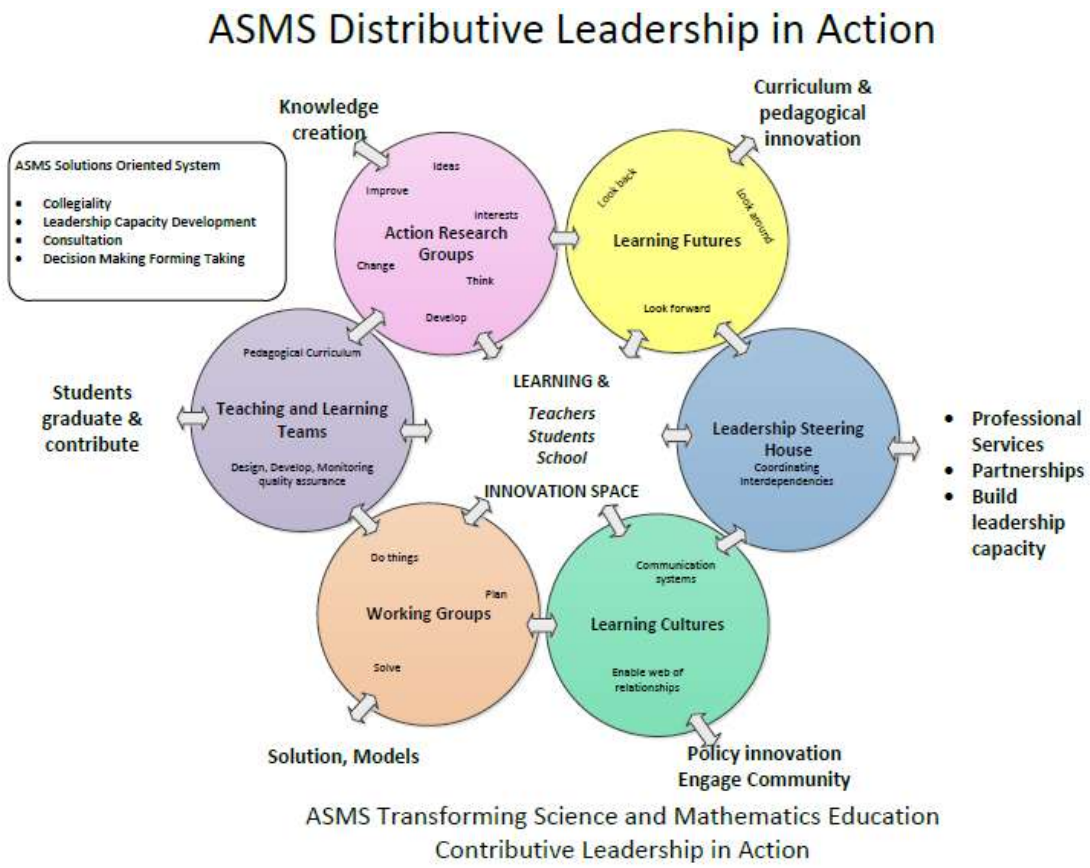

Figure 10: ASMS Distributive Leadership Model 2011

Distributive leadership at the ASMS occurs when the professional and support staff are involved in decision making within all layers of the organisation, including formulating and influencing ideas and being involved in their implementation. Teaching and learning is the school's core business, and is developed, delivered and reviewed by the teaching and learning teams. New ideas for innovation and policy development can arise from any of the ASMS teams. They are then broadly discussed within agendas of various staff teams. Ideas may also be generated within a staff member's action research project and this can be reported formally through the Action Research Group, before being taken up by the leadership team. Ideas can also be developed and consulted through the Learning Futures Working groups, and then further developed and operationalised by the teaching and learning teams, thereby having an impact on student learning outcomes.

Using the distributive leadership model within self-managing interdisciplinary teaching and learning teams, collaborative planning, peer learning and general support for all team members occurs. This support is particularly important for newcomers to the ASMS context, as indicated in the following comment from a school leader:

> *..they are members of those teaching and learning teams..They walk into a collaborative scheduled conversation every week that is critical to them understanding the way we work here..Because in those meetings they plan, they reflect...They talk about students..They talk about the interdisciplinary of the curriculum and that occurs every week.*

The distributive leadership model and teaching and learning teams are further depicted in Appendix A which provides detail about the curriculum and assessment design process. This links to the team based moderation of student work at the ASMS. This process involves interdisciplinary team of about 12-14 teachers who are experts in science/humanities/English. They develop a scope statement for the course, a learning sequence and a learning and assessment plan. Following approval processes, sub-teams then develop the specialist modules, assessment task details and rubrics, and after delivery in classes, designated teachers mark work and provide feedback before group moderation occurs.

Group moderation occurs within either discipline specific or cross disciplinary teams dependent on the assessment task. Some assessment tasks are discipline specific so teachers with the appropriate disciplinary expertise work together to ensure common understandings at the necessary level of specific detail. Some assessment tasks are cross-disciplinary and require the blending of expertise across areas that might include a specific component of scientific knowledge and understanding, english communication and humanities perspective, with multi-marking potentially occurring for a single assessment task.

Through the process of moderating student work such that all students receive equitable results there are many professional learning benefits which are explained by a teacher as follows:

> *Six science teachers working together..we do a moderation of the student work..We all sit there and we look at the work.,.. We mark where we can see evidence and we set the standard through making our own judgements and then we discuss it. We have those really rich discussions..about how I thought of the evidence...what we perceive to be the level that the work is at...We then go off and mark our own class work and we know that we're all on the same page and a student in my class is getting the same feedback and the same assessment as a student in another class.*

The team collaborative professional learning is supplemented by action research opportunities in which teachers can work alone or with others in researching a topic of relevance and interest. The process was explained by the principal as follows:

> *..the culture of action research is there...so that feeds into everything the teaching and learning team does..And it feeds into...where the school's going..and then the working groups feed into that*.

Nature and Quality of Learning

Beyond the flexible ICT-rich learning space, collaborative relationships, the tutor system, collegial professional development and external partnerships, the innovative ASMS science and mathematics learning context is supported by the holistic structures for learning, interdisciplinary curriculum and personalised and self-directed learning processes.

Holistic Structures for Learning
Collaborative, interactive, student-directed learning activities are key aspects of the ASMS innovative curriculum which operates within the state senior secondary curriculum. Multi-level year 10 and 11 students learning programs at the ASMS are structured around three key component aspects:

- an interdisciplinary 'Central Studies' curriculum including Mathematics and Abstract Thinking (MAT) topics: (maths/science, English/humanities/health and personal education and art and design);

- University Studies short courses (team-based activities, research and activities in the university laboratories in collaboration with Flinders University staff eg aviation, pigs politics and Uganda, Third Cup of Tea, Cryptography, Cut to the Quick and Global Enterprise Challenge); and
- supplementary studies (e.g. languages, music, which are generally undertaken at alliance schools off -campus).

Workplace Studies is also available within Central Studies or by negotiation for the purposes of work – related skills development (ASMS, 2009).

The learning structures include three 100 minute sessions daily in relation to Central Studies and MAT, plus a 40 minute Tutor Group session each day immediately after recess/morning tea. Thursday mornings are programmed for 10-week University Studies choices. On Tuesday afternoons there are no programmed classes, with students departing early and staff undertaking professional learning activities. Lunchtime sports activities are also available, with staff and students participating.

In year 10/11 studies, the curriculum aspects are covered using a team-based approach, with various teams operating in various ways. As a teacher indicated in the focus group interview:

> *We work in teams in the Central Studies. I'm teamed with a science teacher…. We can either work individually or we come together…. We collaborate a lot...In the past there've been some different ways of collaborating…we had the class together in that space...He was teaching something and I was teaching something...But it's sharing across the different interdisciplinary programs...and we learned to trust each other.*

For example in the Central Studies Unit 'Technological World' which has a problem solving question of 'Why invent?', and which investigates how energy, machines and engineering materials have been developed and implemented in a social/historical context, there are twelve people in the teaching team.

Table 1 indicates the assessment tasks involved, the disciplinary focus of each task and the teaching team focus for each task. Practical's, tests, film studies and written assignments are involved within this topic.

Table 1: Technological World central studies unit

Assessment task	**Disciplinary focus**	**Teaching team focus**
Energy Efficiency Practical	Physics	3 (Physics)
Periodic table Assignment	Chemistry	3 (Chemistry)
Corrosion Investigation	Chemistry	3 (Chemistry)
Engineering materials Test	Physics	3 (Physics)
Documentary Film Study	English	4 (English)
Scientific Article	English/Science	4 (English)
Materials and Inventions Investigation	History/Science	4 (History)
Techno-History Museum	History/Science	8 (History/Physics/Chemistry)

Year 12 students undertake subjects within the South Australian Certificate of Education (SACE) following on or in conjunction with year 10/11 ASMS studies. Stage 2 SACE subjects offered at the ASMS include various discipline areas such as Australian and International Politics, Modern History, Biology, Chemistry, English Communications, English Studies and English as a Second Language, Research Project, Geography Studies, Physics, Media Studies, Mathematical Methods, Mathematical Studies, Specialist Mathematics and Psychology. Other supplementary subjects may be undertaken at nearby alliance schools.

While the newly-released state-based SACE year 12 studies are framed within a discipline-specific context which differs from the interdisciplinary studies offered at the ASMS in year 10/11, there have been efforts by the ASMS to influence the state curriculum by developing accredited subjects called Scientific Studies that are cross disciplinary (e.g. Human Performance, Avionics). However, it was evident that within the broader state curriculum context, the ASMS has remained focused on its mandate in terms of the development of deep conceptual learning within year 12, as well as across year 10 and 11 studies. An academic captured the school's commitment with the following comment:

> *The ASMS has tried to tread that line between being innovative and trying to get some relational thinking going with students…The ASMS is still developing that higher order thinking and conceptual development.*

This commitment to higher order thinking and innovation is reflected in the ASMS Graduate Capabilities which include operating scientifically and mathematically; communicating effectively; working both autonomously and collaboratively; demonstrating personal and social enterprise, and demonstrating critical literacy (ASMS, 2009).

Interdisciplinary Curriculum

A significant transformative aspect of the ASMS curriculum in years 10 and 11 is evident in the eight 'central studies' areas which involve the new sciences such as nanotechnology, biotechnology, and sustainable futures and the use of integrated approaches.. Humanities concepts such as philosophy, sociology, history and communication skills are also included, as well as art and design, English and health and personal education. Thematic topics include titles such as: *The Body in Question*, *Communications Systems*, and *Sustainable Futures*. Mathematics and Abstract Thinking (MAT) is learned through problem-based learning, competency of identified core mathematical learning and metacognitive strategies designed to develop higher-order thinking skills. Each Central Studies topic has an overarching fertile question which provides both an inquiry focus for learning and the subject of a final assessment task each semester. The fertile questions include: 'Do we need to prove it or is near enough good enough?' in regard to the Mathematics and Abstract Thinking topic, *Patterns of Change* and 'Should humanity control diversity?' in relation to the *Biodiversity* central study.

The value of the fertile question in terms of supporting interdisciplinarity, building deeper conceptual learning and preparation for university is shown in this comment from a teacher:

> *..the centrality of the fertile question…People say they're the kind of questions they'd be doing in 2nd year uni..They research and they work in groups and they inquire into and eventually they present their findings and all those other processes relate to learning.*

There are three interdisciplinary Central Studies topics per semester, two being science based and the other mathematics based. (MAT), with all topics covered during a two year cycle. The topics and structures for 2011 and 2012, central studies details and the accompanying fertile questions are represented in Table 2 as follows (adapted from ASMS, 2009a):

Table 2: ASMS Central Studies and Fertile Questions

Sem 1 2011	Central study area	Central studies details	Fertile questions	Sem 3 2012	Central Study area		Fertile questions
	MAT Patterns of change	Patterns in polynomial, exponential and logarithmic functions and their graphs Applications of mathematical functions and associated concepts through inquiry and reflection	Can mathematics show us true beauty?		MAT Patterns of change Reasonings and relationships	Algebraic, graphical, pictorial, concrete and textual modes of representation to explore relationships and questions of proof with regard to polynomial, exponential and logarithmic functions and their interdisciplinary applications.	Do we need to prove it or is near enough good enough
	The body in question	Fundamental science concepts eg nature of disease causing organisms, response of the human body to stress, impact of physical forces on the body, Human health issues :local and global perspectives	How does the mind/body/environment interaction influence health?		Biodiversity	Diversity of life on planet Earth through the role of evolution in development of species including geological time scales, natural selection, Earth processes such as continental drift and plate tectonics, dating methods and the extinction of species. Other concepts and content include animal and plant structure and function, ecosystems, biodiversity and classification systems.	Should humanity control diversity?
	A technological world	Social impacts of developments in science and technology over time. Investigate developments in the uses of energy and materials over time & social implications	Why invent?		Towards Nano technology	Materials and their properties at macro and micro level and towards understanding the potential of nanotechnology. Applications and challenges include the working of lasers, fibre optics, communications and the creation of molecular machines to manufacture safer chemicals, detect and remove pollution and for the diagnosis and cure of disease	What is nano-reality?
Sem 2 2011	MAT Modelling chance and space	Models that support understanding about nature of the universe. Investigate validity of probabilistic and geometric properties of these models and application to authentic problems	What is significant and how do we know?	Sem 4 2012	MAT Modelling chance and space	Models that support our understanding of the nature of the universe. Investigate the validity of probabilistic and geometric properties of these models and their application to authentic problems.	The universe – fine tuned machine or engine of chaos?
	Sustainable Futures	Sustainability of the Earth is explored in concert with human systems and human behaviour including areas of population studies, food	How can we think globally, act locally for sustainability?		Biotechnology	Genetics and selective breeding to improve fermentation, crop yield and disease resistance to best	Who benefits from biotechnology ?

Sem 1 2011	Central study area	Central studies details	Fertile questions	Sem 3 2012	Central Study area		Fertile questions
		production, water quality and availability, waste management, environmental chemistry and bioremediation. Investigations look at the use of technologies to counter degradation and promote sustainable practices				advantage. Key concepts and content include cell physiology and function, using proteins and the immune system to assay plant and animal health and the interplay between microbiology, public health and the environment. Other content and concepts include the analysis and use of DNA markers and fingerprinting, genetic modification, gene technology and bioinformatics.	
	Communication systems	How humans exchange, interpret, change, adapt, transform and control information and communications. Detailed focus on physics of electrical communication to understand electrical currents and micro processors, and the chemistry of biochemical communication to understand the structure and function of chemicals such as neurotransmitters and hormones.	Are we the controllers or are we the controlled?		The Earth and the Cosmos	Understandings of the sun, moon and stars and their social, spiritual and technological roles. The concepts and content covered include the structure and size of the universe, understandings of time and space, composition of the planets, evolution of the Earth's atmosphere, oceans and geological formations and space exploration. Computer simulation and mathematical modelling of physical phenomena will enhance students' understandings.	In what ways should we explore the cosmos?
	Special InquiryProject				Special Inquiry Project		

The use of the fertile question certainly seems to provide opportunities for inquiry and deep conceptual learning:'...that higher order thinking that you're involved in... the interaction at the social emotional level but also at the intellectual ' teacher).

Deep learning is indicated in the ASMS model which is about initially focusing learning on familiar problems and concepts and then being involved in problem solving and creativity through the additional challenge of working within unfamiliar contexts (see Figure 11).

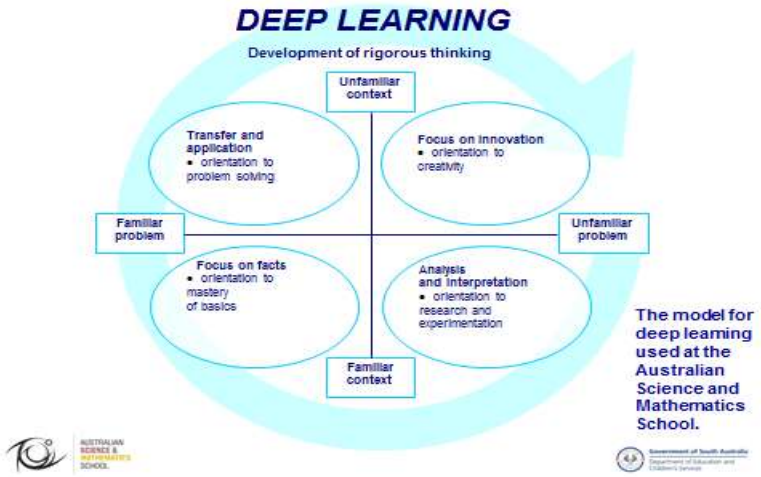

Figure 11: ASMS Deep Learning Model

The following teacher comment reflects the types of views typically expressed about the interdisciplinary approach and the potential for synthesis and deep learning as follows:

> *Our strength is our commitment to interdisciplinarity...it provides everything.. Relationships, curriculum....professional relationships. It's holistic....It defines what we are and we look at a person in a holistic way....We really try to cross the boundaries of subjects...So many times we have these moments when something happens here...something happens there and they come together.*

Personalisation and Self-directed Learning

Linked to the structuring of topics and the interdisciplinary curriculum approaches is the ASMS educational philosophy which is focused on personalisation and independent learning. This is evident in the published learner expectations (ASMS, 2011b) such as understanding themselves as learners and sharing learning with others; being autonomous and self-directing; valuing the beliefs of others and working in groups and independently; using their own experiences to construct and add meaning; identifying and critically evaluating resources and creating meaningful learning products for real world situations and audiences.

A range of strategies is used to personalise the curriculum and to support self-directed learning such as the Personal Learning Plan, opportunities for negotiation within topics, assessment choices and materials being available on the online portal.

The ASMS is committed to helping students become self-directed learners, with the development of the self-directed learner becoming the focus for the 2011 ASMS Research Agenda involving Flinders University School of Education research academics in guiding the design of ASMS qualitative and quantitative research. Formal evaluation through the Macquarie University (New South Wales) is also involved. A key aspect of the Action Research strategy is the annual development of a Personal Learning Plan as a way of tracking and planning of student learning, showcasing learning within the student-led Learning Conversations with parents and tutors and also in recent years, meeting the requirements of the South Australian Certificate of Education. The development of the PLP occurs within the Tutor Group program, with the PLP being built as an electronic portfolio. The digital nature of an ePortfolio encourages students to examine and create links between aspects of their learning. Students include a wide range of digital demonstrations of their learning in the PLP and then create hyperlinks to other relate pieces of their work. Word documents, spread sheets, animations, photos,

movies, WebPages, and scanned images are included within the PLP as evidence of students continuing to reflect on their learning and planning to improve their learning.

Negotiation including in relation to using authentic assessment tasks also plays a significant part in the personalised learning approach at the ASMS. As one teacher indicated in regard to negotiation of learning and assessment within a topic:

> *The flexibility is not confined to the space.... Innovation comes from the flexibility and the way that we negotiate with the students.....Today we introduced a document in film studies...I was talking about a particular type of film that was made in the 1930s and he (a student) said, 'I know that film, can I do that'. And I said, 'That's the way we do things here..you negotiate that with me…we come up with a plan.*

Negotiation was evident in an observed MAT lesson in which students were introduced as a group to the topic focus regarding the History of Mathematics within *Patterns of Change*, and then worked in smaller groups in selecting a famous mathematician to research, with a documentary or other mode of assessment to be negotiated. An assessment rubric was provided to guide student work in relation to mathematical knowledge and skills and their application, mathematical modelling and problem-solving, communication of mathematical information and individual reflection.

The online curriculum available through the school's e-Learning portal is another aspect which is designed to enable students to personalise their learning. Some Year 10 students may study at a Year 11 level or students may undertake year 12 studies, with these opportunities providing a challenge which extends their achievement. In 2011, twelve students are undertaking first year courses in mathematics and science subjects at Flinders University as part of their year 12 studies.

In addition to personalisation, there is considerable focus on ASMS students becoming self-directed learners who are responsible for themselves inside and outside the classroom setting. As one teacher indicated in a focus group interview in regard to observing student learning and the approach of providing feedback on their learning to each other at the ASMS:

> *We've spoken to teachers in other schools and they've just been blown away by the students and how they cope with the process of giving feedback...We've found it a really valuable process...split into groups...outline these are the areas that you need to be looking at...and they do it...I could walk out of the room and they 'd be sitting there doing it ..and not mucking around.*

A student feedback survey used in the research process indicated highly positive responses (80-90+%) from students regarding building on learner understandings, connecting learning to student lives and aspirations, applying and assessing learning in authentic contexts and communicating learning in multiple modes.

One teacher's comment reflects the overall benefits of the ASMS innovative approaches and personalisation of the ASMS as follows:

> *...the emphasis is on the learning rather than the teaching...Our learning theory is focused on inquiry...We have to change the way that we work..personalisation. I actually think that that is really fundamental to what we try to do here...We try to look at the curriculum from a learner point of view and support them. There's a whole lot of flexible ways of working..We work in small groups, one to one, classes work together...flexible ways of working...Pre-programmed materials can be put on the portal.*

Impact and Effectiveness

Grounded in transformative mathematics and science practices, a reconsideration of senior secondary education and regenerating student interest and participation in relevant career pathways, the ASMS is an established year 10-12 specialist senior secondary school which embodies sustained innovation and impacts over an eight year period. Academic achievement and university pathways data; parent/student/staff satisfaction surveys and interviews and professional learning documentation provide evidence about its impact and effectiveness.

The academic impact is evident in that over 80% of students are consistently obtaining their first choices in gaining entry to university programs on the basis of successful year 12 results obtained within the South Australian Certificate of education processes (ASMS Annual Report; 2009; ASMS newsletter, 2011). Additionally, significant numbers of students continue in mathematics and science-related studies as indicated in a school leader's comment that: 'around 82% go into maths/science pathways….(Even) students who are on the margins..20% are going into science'.

Furthermore, leadership and staff interviews indicate that beyond achieving their goals of tertiary entrance, ex-students are very positive about their ASMS background in terms of supporting students in their organisational and time management skills and in being independent learners.

The end result of personalised learning and building skills of independence is captured by one teacher as follows:

> *It's that very personal interest in what happens...how much they value the opportunity here to develop their own style of learning...And when they go to university, they're already accustomed to managing their own timetable.*

Satisfaction among current parents and students in terms of the ASMS preparation for future study is also extremely high as represented in a student comment such as: 'the structure of this school is going to help us in the near future when we get to uni...it's setting us up for uni'.

Beyond academic success, the purpose-built and technology-rich ASMS facility has fostered highly positive student-teacher relationships and also created an environment to support inclusive student interactions. Attendance rates are about 4% higher than state and regional averages (ASMS, 2011a). Parent, student and teacher satisfaction is evident in surveys regarding teaching and learning quality, support for learning, relationships and communication and leadership and decision-making (ASMS, 2009a). In terms of providing positive benefits for social and emotional development and for building lifelong learning skills, one parent's comment reflects more general views about the benefits of the ASMS environment:

> *I've never seen my daughter have to work hard at school*…(she's) *enthusiastic about the school…..(It's) a lot like a uni….broadens their mind completely…a whole lot of other stuff….personal growth….she's learned here.*

The positive school environment is further reflected in the Australian Council for Educational Research School Life longitudinal study. ASMS student responses indicate between 80% and 90% agreement with positive aspects of the school and satisfaction with teaching, and student responses on an annual basis are consistently higher than the national average (ASMS, 2009a).

The wider focus on professional learning, including beyond the school context, recognises the importance of rejuvenating student interest in science/mathematics and career pathways through transforming teacher beliefs and pedagogical practices. The impact of the professional learning focus is that 'the vision of the school has proven to be world class leaders in the science and mathematics education in senior secondary years through...reshaping the whole concept of senior science and mathematics education' (university academic).

Conclusion and Transferability

The Australian Science and Mathematics School in South Australia provides a highly recognised model of innovative educational practices focused on transformative mathematics and science education and operating within a whole school context. Sustainable innovation is supported through a strong sense of ownership and collegial learning which permeates the school community and which has been nurtured over an extended period of time. The challenge involved in regularly working with other South Australian, Australian and international visitors in supporting their journey towards transformative teaching and learning provides further opportunities for ongoing questioning, reflection and trialling of new innovative practices across the ASMS learning community.

While the ASMS is a purpose-built upper secondary school and students and teachers have selected to be part of this schooling environment, many other educators from Australia and beyond visit the school to learn about their approach. The interdisciplinary approach, multi-age groupings and negotiated learning approach have transferability to other contexts, with these aspects co-existing within an overarching state based curriculum framework.

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Appendix A: Team based approach to assessment and moderation at the ASMS