

John Monash Science School

Aims of the ILE and the nature and history of the innovation: holistic picture of the organization

The John Monash Science School was established in response to a perceived lack of specialists entering the Science and Maths disciplines and occupations. Based on a partnership between the Department of Education and Early Childhood Development Victoria, (DEECD) and Monash University, this Innovative Learning Environment showcases new ways of thinking about curriculum and pedagogies and reconceptualises physical and virtual spaces for effective student learning. At the time of this report, in December 2010, the school had been operating for 10 months.

School context

The John Monash Science School (JMSS) is a new school, situated at Monash University, Clayton Campus, in the South Eastern suburbs of Melbourne. Whilst situated on the campus, the school is quite distinct from the rest of the campus, with dedicated car parking and facilities which are self-contained. For specific purposes, staff and students access other facilities of the University, including the Monash Science Technology Research and Innovation Precinct (STRIP). The STRIP is home to University and Corporate enterprises developing leading edge technologies and research capacities (Monash University, 2005).

The school is located just metres from the existing science and medicine faculties where the best minds in Australia are creating solutions for the future. It will provide the school's students and staff with unique opportunities to engage with university teaching and research staff (Vice-Chancellor Richard Larkins, Monash Newline, 2009)

JMSS is purpose built (see Figure 1 & Figure 2). It was designed by architects, in consultation with academics from the Education and Science Faculties at Monash University and with input from neighbouring schools and representatives of the DEECD (Eastern Region). At the time of the Principal's appointment, the school

was a concrete slab and not much more. All the building plans were in place. A steering committee, comprising architects, senior education officers from EMR, senior academics from Monash, a couple of local principals, managed the decisions around buildings and curriculum development in the early years. Experts in science were consulted on the layout of the labs.. Since I began working on the project, I was able to make two or three changes to the building design, which changed some aspects internally, but about the physical lay-out was pretty much confirmed. However we had complete ownership over the development of the vision for learning and the new curriculum, and that's where we got to work with the most energy in the early days (Principal).



Figure 1. John Monash Science School Design



Figure 2. John Monash Science School Building

JMSS is a selective specialist entry state school. In Victoria, there are four other selective entry schools¹. Typically, selective entry schools provide ‘an educationally enriched environment for high achieving, academically gifted students’ (Department for Education and Early Childhood Development (DEECD), 2006). JMSS is different from the other selective entry schools, because it is a specialist school. Whereas entry to the other selective entry schools is subject to a centralised exam process, the enrolment policy at JMSS reflects a more individualised and specialised process, based upon the ‘applicant’s passion and aptitude for science, capacity for logical and numerical reasoning, and mathematical ability’ (John Monash Science School, 2010). An entry exam is undertaken, and the candidate is also interviewed to ascertain suitability for the school.

In its first intake of 191 students, JMSS has enrolled students from 90 schools around Victoria. There is significant cultural diversity amongst the students, as represented at a recent school event celebrating ‘Harmony Day’ where students highlighted their connections to 39 countries (Principal). Similarly, students come from many different parts of Victoria and the distance between some students’ homes and the school has meant that a number of students travel significant distances to attend, or are currently involved in home-stay or billet programs. The students in this school are described as ‘particularly able’ (Principal) and as ‘highly motivated and get a kick out of learning something new and seeing connections between the science disciplines’ (Head of Science). Staff members have commonly reflected that the ‘notions of clever kids’ which had preceded actual students enrolments have been revisited and reconsidered.

I suppose when you’re thinking about what’s a kid who does specialist science look like, you could get all sorts of opinions and none of them have been right so far. You know you wouldn’t have predicted that 86 kids would be supersonic musicians. That we’ve got kids who want to continue in language and we’re running 16 languages. You wouldn’t guess that we’ve got a Victorian under-age golf champion here who’s off a handicap of 1 or 2. We’ve got an equestrian. We’ve got an open water swimming who swims 2 hours before school and 2 hours after school every day and his main event is 10 kilometre swimming. So what we’ve actually found is probably not what we imagined. That you might be gifted and interested in science but generally you’re going to be gifted and interested in something else. And that could be literature or humanities or things like that (Assistant Principal).

These changing perceptions of who the learner is at JMSS, has had a significant impact on teacher practices and expectations. This will be discussed in subsequent sections.

The teaching staff at JMSS are young and enthusiastic, outstanding in their previous roles and clearly committed to the pursuit of excellence in teaching and learning. At the time of writing this report, there are 20 full-time staff, including 1 Principal and 2 Assistant Principals and 14 teaching staff. Fractional staff positions cater for Music and Chaplaincy, and Year 10 Physical Education ‘which looks more like recreational sport’ (Principal). The last is facilitated in partnership with Monash Sport. All teaching staff, including the Principal and Assistant Principal, have an active teaching role within the daily learning experiences of the students, and are considered affiliates of Monash University. In the same way, it is ‘not unusual for Monash academics to be taking sessions within the school’ (Head of Science). Most of the current teaching staff have a formal leadership role within the school, and the school is currently preparing to advertise and appoint new staff to cater for the increased number of students in the second wave of appointments.

This research project has provided a valuable insight into the design and implementation phase (Blackmore, et al., 2010) of an innovative learning environment. The school has been designed on the basis of sound educational and architectural principles and three first months are about how

¹ Melbourne High , MacRobertson Girls’ High, Nossal High School, Suzanne Corey High School.

teachers and students enact these principles. At such an early stage in the life of the school, there is already significant learning to be drawn from the relationships and partnerships between different stakeholders of this school, and the design processes of the physical environment. The benefits of recognising expertise and autonomy within school leadership which enabled staff to develop rich curriculum and assessment practices, was associated with a culture of collaboration and respect between staff and students.

Origins and development of Innovative Learning Environment (ILE)

Partnerships

The John Monash Science School was ten years in the making, from early conceptualisation through to the first enrolments of students in 2010. Key player at Monash University, and a catalyst for this endeavour, was Emeritus Professor Richard Gunstone. Deputy Vice Chancellor and Vice President (Resources), Ms Allison Crooks enthused Professor Gunstone with the idea of developing a specialist science school within the prestigious STRIP. A new Dean of Science at Monash University from New South Wales became involved in early negotiations about the possibility for this school.

I lived in New South Wales prior to becoming Dean here and Sydney is full of selective and specialist schools. There's at least 20 - 25 of them. The private school network is nowhere near as well developed in Sydney. The state schools are of far better quality than I suspect they are in Victoria. I really came from that philosophy of 'this is the sort of school that kids from working class backgrounds can really thrive in'. My parents were working class and I just appreciated the opportunity to get into education and I attribute where I am now to the fact that I went to a selective high school. It gave me an opportunity to learn science and appreciate science in a school that had decent labs and good teachers (Dean of Science).

The motivation to develop JMSS was based upon a number of drivers. At the most fundamental level, it was about enthusing learners in the Science Curriculum, by improving the quality of secondary education, which would increase the number of students across the tertiary science level.

We felt science wasn't understood at the secondary level. It wasn't particularly taught well. And there was a decline in science enrolments at the tertiary level worldwide. So the concern for us was why? I mean science should be exciting. Science should be a great thing. The answers to that are very complex and there are all sorts of reasons for it. There was a lot to be learned through a specialist Science school (Dean of Science).

At a more political and social level, the rationale of the school was to increase student numbers in science and maths, as a way of responding to the ongoing impetus for science, technology and innovation which enabled economic growth (Monash University, 2007). It was pitched in direct response to challenges identified within the government's strategic document *Growing Victoria Together* (State Government of Victoria, 2001).

The concept for John Monash Science School was presented to the Monash University Council after extensive research into similar settings around the world, but which concentrated on other recent innovations in Science Education, such as the Australian Science and Maths School (Department of Education and Community Services, 2002), founded in 2002. The Dean of Science proposed the school at Monash University to the DEECD, as a rich partnership opportunity.

In 2001 I went to a Monash University Council meeting and as part of my portfolio as the new Dean I said I would like to establish a science high school on the campus. A school that I said was

originally selective but in fact it's turned out to be specialising in science, that includes mathematics, as a way of developing new programs in science teaching. It means training science teachers in a new way. And also it's not all altruism, as a way of recruiting students to Monash particularly in the Faculty of Science. And my proposal was that we allocate a plot of land on Monash ground and get the department to build a school and that Monash put some money in to help Faculty of Science members relate to the teachers and help them design the programs (Dean of Science).

At the time of this presentation, there was considerable considerable angst in the then Department of Education (Victoria) regarding selective entry schools, as well as amongst parent groups (Dunn, 2005). A number of schools were closing around the area, and there was a perception that this school would potentially remove high achieving students from their local community schools (Monash Academic). The other concern highlighted by teacher unions in the media was about inequitable allocations of resources in the state education system.

The state's teacher union has warned neighbouring schools could suffer, as the elite schools attract better resources and more academically talented students. The union will seek assurances that state schools neighbouring specialist and select-entry schools would not be disadvantaged.

'We wouldn't want to see one school being resourced better than another,' Ms Peace said. "All schools should be properly resourced, whether they are a specialist school or a standard secondary or primary school.' (Smith, 2007)

According to the Dean of Science, between the first presentation in 2001 and subsequent discussions, and presentations to Monash University and the DEECD, 'interest in the school waxed and waned until about 2005 or 2006'. During this time, the concept of the 'Science School' attracted much attention from other community stakeholders, including potential Private School partnerships and Corporate groups. 'It was as if everyone else could see the value in what was being proposed except for the two big players' (Monash Academic).

Then people started getting serious and then it just took off. We had to get a budget. We had to talk to the state government. We had to talk to the Minister of Education. Then we had to wait for Education to take it to the Treasurer, then to get it past Treasury. So there was a sequence. Probably a year or 6 months between each of those events until finally the government announced the formal \$20 million for the school (Dean of Science).

At the end of 2008, for an early 2009 start, the first Principal, Peter Corkill was appointed. At the time of his appointment, he was

honoured to accept the role and was looking forward to a new learning environment where teachers and students could explore learning together. Students will be encouraged to excel. The school will be a place where they will be challenged by contemporary thinking and engaged in helping find solutions to current pressing problems. And with our partner Monash University keen to work with us on creating new curriculum opportunities for schools informing teaching practice state-wide, we indeed stand ready to shape our future (Monash Newline, 2009).

Upon his appointment, the JMSS Principal was situated at the DEECD's Eastern Regional office, and worked closely with the Regional Network Leader and the Regional Director. A recently retired Principal, Phil Gardener² was appointed as Project Officer. The Principal worked closely with Phil during this time. Funding was negotiated to bring new members of the school's leadership onboard including 2 Assistant Principals and a Business Manager. At the time of their appointments, the JMSS staff moved to an office on the STRIP at Monash University. By the beginning of the final

² Phil Gardener was unable to be interviewed for this Case Study.

quarter of the 2009 school year, other leaders in Curriculum had also been appointed, and other staff positions were being advertised. Each of the staff members interviewed for this project have stressed their perceived value in having the time, prior to having students enrolled in considering the what the school would be like, and how they were going to operate.

What do you do when you start this? It's massive. You're starting a new school from scratch. You've got an open slate I suppose. And we have great teachers with great ideas. And Peter [Principal] is confident enough and has a strong enough sense of what it's all about to think really big and really differently (Assistant Principal).

Certainly, within the newness of every aspect of the school, and a permeating confidence in the leadership and the support which is offered through academic partnerships, teachers at this school are excited about the possibilities which are ahead over the next years.

Being at a new school, there are not a lot of the blockers you might have at another school and just the attitude of the school leadership and administration that anything is possible. And we've really just been let free to run with all of our... even fanciful ideas. Another school might look at that and think 'oh you can't do that' or 'that'll never work', but that's certainly not the attitude here (Teacher).

It was when each of these decisions, infrastructures and opportunities identified during this time were subsequently realised and adapted, that calls for student applications were advertised in the middle of 2009.

We had an open night last year attended by 600 odd people but we had no building to show. We had the structure of a curriculum. We had some really enthusiastic principal class officers and some wonderfully enthusiastic Monash academics. 340 people came to sit the assessments, both written and interview, and from that we've got our 191 students. I characterise those parents as risk takers and the kids as risk takers as well. Most were probably really happy in their schools but they saw a different opportunity here. In many cases it was the student who drove this. 'I know about this school, I want to go there'. From what we know of the kids because we interviewed most of them, the kids that are here are genuinely interested in and passionate about science (Principal).

Thus, with an emergent staff in place, a rich partnership with Monash University in place, the building process underway, and a student cohort enthusiastic to transition from their previous schools, the John Monash Science School opened in 2010 as an Innovative Learning Environment. In the following section, the characteristics and patterns which make John Monash Science School a rich and innovative site for teaching and learning, and much future research, will be outlined. In subsequent sections the innovative and approaches to curriculum and technological infrastructure which provide students with multiple opportunities for success and diversity within their studies will be described.

Structured patterns and characteristics of ILE: layout, sequencing and mix of learning activities

In this section, the flexible learning spaces, and how the spaces influence the multiple ways in which teachers and students interact with each other will be described. The 'culture of collaboration and collegiality' (Principal) which is exemplified, as well as the staff's ongoing commitment to Professional Learning is also highlighted. In thinking about the rich partnership between the University and JMSS, it is also important to describe the ways in which this is evolving. Finally, the

other dimension which demonstrates innovation enabling student learning is the affordances of technologies within the learning context.

Flexible Learning Spaces

When the school first opened in February, 2010, the physical learning environment was not yet complete as was the case for the learning spaces (Blackmore 2010). The students commenced classes in a set of traditional University tutorial rooms and laboratories until the end of Term 1. Whilst for many school staff and students this would have been a major disappointment, at JMSS it has served as a way of contrasting teaching and learning opportunities across different physical learning environments.

We watched our school being built. We were so excited about everything that was happening, and the unfinished buildings were just another thing to look forward to. Being at the Uni was exciting and we felt very special. But we could see our school, and we thought that was more special (Student).

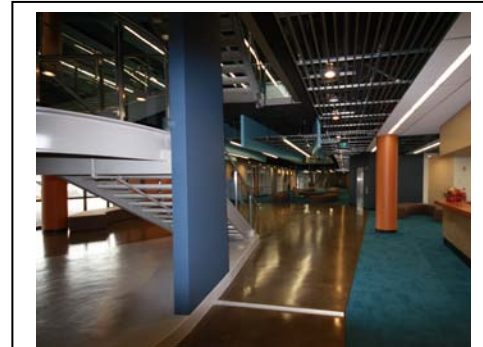


Figure 3. JMSS - Central ground floor

The physical spaces at JMSS are striking, for the overwhelming sense of openness and natural light. The three storey building is constructed in such a way that each floor has a range of spaces which are utilised in a number of ways. In the overall design, the ground floor is designed to be a multidisciplinary and communal space, whilst the first and second floors duplicate each other and are able to be configured in a number of ways for specific learning experiences.

On the ground floor, behind a central reception desk, there are administrative offices and formal meeting rooms which adjoin the Principal's and Assistant Principal's offices (see Figure 3). There is also a small staffroom, which doubles as a staff meeting room and a lunchroom. Adjoining the learning bridges are a number of smaller break-out areas, often used for student meetings or small teaching groups. The learning commons and larger spaces have modular furnishings which can be easily reorganised for different functions (Figure 5). These spaces are used for formal learning experiences as well as recreational areas during break times. A small cafeteria is also available (Figure 4).



Figure 4. JMSS Student spaces



Figure 5. JMSS Flexible Learning Spaces



Figure 6. JMSS Science laboratories



Figure 7. JMSS Breakout spaces

The first and second floors duplicate each other. They are organised into halves, divided by learning bridges. Within each half are two of the Pastoral House Structures, from which students usually begin their days. The first and second floors are also open spaces containing a number of formal science laboratories and smaller breakout rooms adjoining the larger spaces. Modular furniture is used to generate the boundary of each specific learning area, each of which can be re-configured for different activities. Within the flexible learning spaces, there are a number of interactive whiteboards, data projectors and other resources.

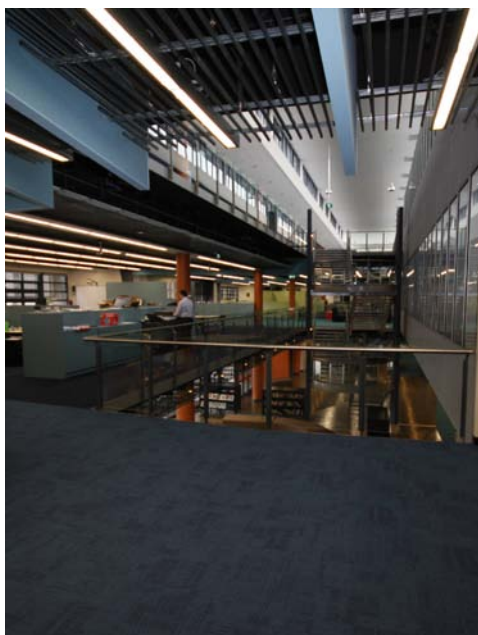


Figure 9. JMSS Learning Bridges



Figure 8. JMSS Teacher's working spaces

The teachers' planning areas are also incorporated into the open spaces (Figure 8). Rather than having a separate space, modular furniture is also used to generate a boundary for each teacher's area.

Different groupings of teachers are located within these shared workspaces according to which House group of students they are associated with. This was a new way of working for the staff at JMSS.

Even just day one, when we came in and the staff tables were set out, there were sort of gasps of 'Where's my desk? Where am I sitting? Where's my folders? My pigeon hole?' That settled very quickly after 2 or 3 days and that was... I mean any sort of change of space or whatever is a big shock and that... in the end that's been a real benefit and I think everybody sees the benefit in that. It has almost forced us to work with each other in the same ways we expect the students to (Teacher).

And

I think that working in an open space can be seen as intimidating and lots of people when they tour through here can't believe that we don't even have separate office areas, but I think that's part of the beauty of it. But, before I came here, I'd never really thought about it (Teacher).

The students also identify advantages for teachers being in the open spaces. In leading a tour through the school, the student commented

Teachers don't have separate offices. They're out here with us as well, and we think it's really good because we know where they are and we can talk to them when we need to.

Upon this, a teacher reflected:

You see the kids, they're more accountable because we're always there and we're more accountable in a way because ...well for the same reasons.

Throughout the interviews with both staff and students, it is clear that the physical learning environment has had an impact upon the teaching and learning experiences during this year. Teachers and students alike have commented that the environment 'forces you to work with others, even in areas you don't usually work with others' (Student). The large spaces have afforded teachers choices in the ways they enable students to work in groups, and vary the size of their interactions. In some instances, teachers highlighted the benefits of being able to bring large groups together in ways they never had.

We actually don't have walls in our classroom. We block class together so there's... for example in Issues Studies we have 75 kids with 3 staff members which means we can then break those groups up into a whole range of different environments. We can divide them based on ability, interest, or just randomly. And so that also gets kids to meet and work with other kids (Teacher).

For one of the teachers, the opportunity to work in an open space, alongside other teachers was one of the aspects of working here that attracted him to working at JMSS. Whereas, in other settings his science teaching had occurred 'in a small lab behind closed doors' this year, he had not yet taught a class on his own (Teacher).

Open spaces in VCE, and in science in the labs is something quite unique. To have double labs with so many clever people all firing off each other. Every class brings aha moments which are different aha moments from other experiences I've had. It's very energising . . . what happens between students and students and students and teachers, and teachers and teachers in these spaces (Teacher).

The other advantage that teachers identified in working in these environments was in the possibility of 'knowing what others are doing' and in learning from one another (Teacher). Working in the open spaces enabled teachers to 'have a stronger sense of what the students are learning' and the ways in which richer connections could be made between different areas of learning.

Everything is open and we're learning from each other and there's constantly people walking through and the kids don't bat an eye lid now, they barely even look up. You know I'll often be sitting in my work space and I'll hear another class going on and I'll think... I'll see someone doing something, and I think oh that's a great idea. I also struggle with some of the things the kids are learning, and it makes me want to know more (Teacher).

And, in the same ways in which the physical learning spaces enable rich experiences and opportunities for staff and students, there is a mindfulness about the ways in which 'strong, supportive and professional relationships between staff and students' (Principal) are nurtured. In the following section, some of the strategies which facilitate such an approach are outlined.

Staff and student relationships

Staff and student relationships are considered central to the opportunities for success in education at JMSS. There are a number of ways in which this is evident, including the *Staff Code of Professional Practice* and the *JMSS Learner's Developmental Framework*. A vertical house system, induction programs and homework clubs also support students' learning experiences .

Staff Code of Professional Practice and the Learner's Development Framework

The *Staff Code of Professional Practice* and the *Learner's Development Framework* are both organised around UNESCO's *4 Pillars of Education* (Delors, 1996). The four pillars are 'Learning to Live Together, Learning to Know, Learning to Do and Learning to Be'. The four pillars intend to provide a means of thinking about the various dimensions of education across the lifetime of an individual.

There is a need to re-think when in people's lives education should be provided, and the fields that such education should cover. The periods and fields should complement each other and be interrelated in such a way that all people can get the most out of their own specific educational environment all through their lives (UNESCO Institute for Lifelong Learning, 2010, p. 3).

In thinking about the dynamic nature of learning, and a strong commitment to building a community of practice, the leadership team with input from the staff group and the students, have generated partner documents which clearly articulate a vision for the culture of the school. In Table 1, the two documents have been drawn together to represent the ways the 4 pillars have been used to think deeply about the emergent population of JMSS.

Table 1 - John Monash Science School 'Staff Code of Professional Practice' & 'Learner's Developmental Framework'

	Staff Code of Professional Practice	JMSS Learner's Developmental Framework
Learning to live together	<p><i>Focused on building sound relationships</i></p> <ul style="list-style-type: none"> We create a sustainable, safe, encouraging and supportive environment conducive to effective learning and aimed at developing core skills, values and attributes in our learners. We build effective collaboration by working constructively together, considering and valuing the input and viewpoints of all. We build positive, respectful, and caring relationships with all community members. We value and celebrate diversity and are inclusive of others. We work effectively in teams to ensure student outcomes are maximized in open, sharing learning practices. 	<p><i>Focused on building sound relationships</i></p> <ul style="list-style-type: none"> Our learners build effective collaboration and teamwork by working constructively together, considering and valuing all input and viewpoints fairly. Our learners build positive, respectful and caring relationships with all community members, and celebrate diversity. Our learners contribute to the creation of a safe, welcoming, encouraging and supportive learning environment and community. Our learners have a global perspective, know and care about the world and its communities, and seek to live sustainably and impact positively now and in the future.
Learning to know	<p><i>Focused on our professional learning</i></p> <ul style="list-style-type: none"> We know our students and place them at the centre of teaching, learning, decision-making and action. We undertake professional learning that reflects current research, DEECD policies and initiatives. We share our expertise, knowledge and developed resources with colleagues, and actively develop professional networks and partnerships in the wider educational community. We regularly and critically reflect on our teaching practice through multiple sources of feedback to improve the quality of teaching and learning at our school. 	<p><i>Focused on thinking and understanding</i></p> <ul style="list-style-type: none"> Our learners are effective inquirers, able to ask meaningful questions which probe understanding, and take risks in their learning. Our learners are critical thinkers, able to analyse information, evaluate evidence and produce informed conclusions. Our learners are creative thinkers, open to new ideas, imaginative and resourceful in their use of different strategies and approaches. Our learners are reflective, aware of their own skills and abilities, and open to feedback to improve their own ideas or performance.
Learning to do	<p><i>Focused on Professional Practice</i></p> <ul style="list-style-type: none"> We provide high quality teaching, learning experiences and assessment strategies informed by best practice to promote effective learning in our students. We work collaboratively toward a shared view of effective learning and teaching so that consistent approaches to pedagogy are practiced. We set and maintain high expectations of ourselves and our students. We develop and implement a personal professional learning improvement plan that contributes to school improvement and our individual professional growth. 	<p><i>Focused on knowledge and skill acquisition</i></p> <ul style="list-style-type: none"> Our learners are adaptable, being able to listen effectively with change, skilled in the use of modern technologies, and prepared to meet any challenge with optimism. Our learners are effective communicators, being attentive listeners and also articulate in both written and spoken media. Our learners are persistent, being able to work effectively through difficulties, and resilient in the face of set-backs. Our learners develop the competencies necessary to advance their learning in specific disciplines, and are responsible for their own learning.
Learning to be	<p><i>Focused on developing good people</i></p> <ul style="list-style-type: none"> We act ethically, responsibly and with integrity. We encourage everyone to achieve their personal best, and positively reinforce their efforts with a sense of optimism and a can-do perspective. We advance the teaching profession through high standards of professional behaviour, punctuality and dress. We welcome people new to our community and help them transition quickly into their environment. We recognise and celebrate the achievements of all members of our community. 	<p><i>Focused on developing good people</i></p> <ul style="list-style-type: none"> Our learners are well-rounded with a broad range of skills, perspectives and interests. Our learners strive to achieve their personal best in everything they do. Our learners are optimistic, confident, enthusiastic and passionate about learning. Our learners are able to examine issues from a wide range of perspectives, and understand the need to act honestly and ethically when making decisions. Our learners value and develop the dimensions of leadership.

According to the JMSS Student Engagement and Well-being Policy (Corkill & Morris, 2010) the core mandate of the school is a 'responsibility to provide an educational environment that ensures that

all students are valued and cared for, and feel a sense of belonging which enables them to engage effectively in their learning' (p. 12). It is through the Staff Code of Professional Practice that the commitment to fulfilling this responsibility is achieved. In the same way, the JMSS Learner's Developmental Framework articulates a vision for an educational environment and both the qualities and aspirations for teacher pedagogies and student learning. The Framework is a commitment 'to develop core skills, values and attributes' in all learners through 'learning, teaching and daily interactions to best prepare all members' for lifelong learning (p. 14).

Teachers refer to 'the Framework' consistently in their teaching, and in their planning.

They own the document. They created the document. It is continually refined. It must be up to its third, fourth or fifth go, now. It was one of the very first things we did. Peter did the first draft because it was the start of a vision. You know, a consistent set of expectations for staff and for students. As more people come on board, we visit it again, because the vision changes, even a little bit. If we sign on something like this, it means we have to follow it. Like a contract of sorts. You have to have expectations right (Assistant Principal).

During one observed whole staff meeting, the *Learner Developmental Framework* was the subject of staff review. During the meeting, the main objectives of the school were reviewed, and staff, in small groups talked about the students in their school. With one eye on the Framework, the teachers considered the ways in which each of the 4 pillars were evident within daily practices of the school. One teacher commented:

I'm sure when kids enrolled here, they thought that they were just in for the Science and Maths . . . well, more than that, but I'm sure they and their parents thought it would be all academic. I've thought about this since our last meeting, and this could almost be a specialist school just in being and living together, especially for teenagers (Teacher).

Through a variety of discussion strategies, the teachers generated long lists of the ways in which the 4 pillars were apparent. They then undertook a critical analysis, thinking about the quality of those experiences and where there were gaps in the experiences which were offered to students.

This is year one. We know that next year's student intake will be different, and that this year's group now have expectations. It is crucial as we begin planning for next year to think about what it is we are doing here, and how we are progressing. I know we are doing some great things, but we need to know if there are areas which are just not being addressed (Principal).

Staff were confident that the 4 pillars were being addressed, but suggested that they 'hadn't really thought about how rich some of the opportunities were' in mapping across a number of aspects of learning (Teacher). Two staff members became deeply engrossed within a conversation about how their approach to curriculum would be best articulated within the pillar *Learning to Know*, 'without looking just like any other curriculum document, which would never do it justice' (Teacher).

I firmly believe that we don't just teach at a school to teach kids content. We are also modelling behaviour to them and I think it's important. The code of practice and the Framework work together so that the kids see that we're working as well and that we have relationships with other staff members and we're learning. And we have to work to the same expectations that they do. At the end of the day, here, it doesn't matter whether you are a teacher or a student, you're working to be the very best. Working under the same kind of pressure means that we all get each other. It's funny to think about it like that (Teacher).

Vertical House System

At JMSS, there is a vertical house system in place, which nurtures more intimate relationships between smaller groups of students and key staff members. There are four house groups which are named Wood, Flannery, Doherty and Blackburn, after distinguished Australian scientists (Fiona Wood³, Tim Flannery⁴, Peter Doherty⁵ and Elizabeth Blackburn⁶). Each house group has an appointed Head of House, and three other teachers associated with it. The Head of House is the first point of contact for each student or parent in regards to their well-being or academic achievement. The teaching staff members within the House are referred to as Tutors. The tutors oversee 'some of the practical things like attendance and coordinating kids, or teachers, to make sure everything is going as it should be' (Teacher) as well as participating in the negotiation of Individualised Learning Plans.

I am in Wood House. As a girl, it is wonderful to be in a woman scientist's house. But the Houses, you know, they help you to know other people. I didn't know anyone here. My Head of House is very nice, and she knows me more than teachers at my last school ever did (Student).

The House Structure of the school enables students to develop the leadership dimension of their learning, referred to in the Learner's Developmental Framework. Each house has a student leadership team, including house captains and Student Parliament Committee Leaders. The student leaders within the houses are formally recognised within the school's Student Engagement and Wellbeing Policy as operating within the school's responsibility to ensure the personal and academic wellbeing of all students.

I am the Head of a House, here. There are some parts of the job that are very administrative. Most of the job though is building relationships with students and helping them to know each other and support each other. We celebrate our triumphs and watch out for each other in times of stress. These students are very good to each other. It's like here, they have the chance to lead in ways they never have before. Often, these kids were the silent population in their schools . . . you know, the nerds (Teacher).

³ Dr Fiona Woods AO, is the Head of Royal Perth Hospital's Burns Unit and Director of the Western Australia Burns Service. She is the co-founder of Clinical Cell Culture, a private company recognised in medical circles for its world-leading research and breakthroughs in the treatment of burns. Dr Fiona Wood is also a Clinical Professor with the School of Paediatrics and Child Health at the University of Western Australia and Director of the McComb Research Foundation. She has become world renowned for her patented invention of spray on skin for burns victims, and for leading a courageous and committed team in the fight to save 28 Bali bombing patients suffering from between two and 92 per cent body burns, deadly infections and delayed shock (Australian of the Year Awards, 2005).

⁴ Tim Flannery is one of Australia's leading thinkers and writers. An internationally acclaimed scientist, explorer and conservationist, Tim's books include the definitive ecological histories of Australia and North America. He has published more than 100 peer-reviewed papers. As a field zoologist he has discovered and named more than thirty new species of mammals and at 34 he was awarded the Edgeworth David Medal for Outstanding Research. His pioneering work in New Guinea prompted Sir David Attenborough to put him in the league of the world's great explorers and the writer Redmond O'Hanlon to remark, "He's discovered more new species than Charles Darwin." (The Weather Makers, 2010)

⁵ Peter Doherty is a Nobel Laureate for his contribution to science research. With Rolf Zinkernagel, he won the Nobel Prize in Physiology or Medicine discoveries concerning the specificity of the cell mediated immune defence (Nobel Prize.Org, 1996)

⁶ Elizabeth Blackburn was born in Australia and went on to gain her M.Sc. at the University of Melbourne. She later studied at Cambridge and Yale and is currently Professor of Biology and Physiology at the University of California. In 1998 she was the winner of The Australia Prize for her work in molecular genetics. In 2009, Elizabeth Blackburn was awarded a Nobel Prize for the discovery of how chromosomes are protected by telomeres and the enzyme telomerase (Nobel Prize.Org, 2009).

At JMSS, the students compete in sporting and academic pursuits as part of their house including a Swimming Carnival. Students will remain in their house throughout their enrolment in the school. In 2011, the sizes of the houses will double as the second cohort of enrolled students begins at JMSS. The houses also provide support for the induction of new people to JMSS.

Induction programs

The experiences offered at JMSS for teaching and learning are often contrary to those encountered by staff and students in their previous school contexts. Given the Staff Code of Professional Practice and the Learner's Developmental Framework are so closely aligned with the 4 pillars, and also build upon the strong and supportive relationships which are possible within the school environment, notions of transition and induction have been dominant discourses amongst leaders and teachers. Teachers were mindful that 'as young adolescents at a challenging time of their lives' (Teacher), students would need to be inducted to the vision of the school.

In my last school, we ran some amazing programs for our Year 9s because quite frankly we knew that the industrial model of education was just not working for them. It is a time in the kids' lives of transition, and they don't necessarily see that what they are doing in school is useful. We made it useful. And, making things useful changed a lot of behaviours and increased student engagement. Here, everything is 'useful'. It's what the kids want to do, but because everything is different, we had to help them to learn about a more mature way of coming into this school and into the university. We needed them to do orientation to make what we wanted to do work (Assistant Principal).

The Orientation or Transition process for JMSS commenced in October 2009 for the students of 2010. Information evenings provided staff with the opportunities to present their curriculum plans to students and their families, and for families to seek any clarifications. At this time, possible learning pathways and opportunities were also presented to students, to stimulate their thinking 'about what could be' (Principal). Each student, with their family then met with staff in a 'course counselling interview' to 'plot the student's course'. By the end of the year, each student had received information relevant to their course, including a timetable.

We had a lot of data about these students before they actually came. Meeting with them to talk about their aspirations, and even think about what subjects they were doing helped me to know them even better . . . before I actually knew them. But I was planning for a much more known group than I had ever planned for. The student's orientation was as much for us as them (Teacher).

The first three days at John Monash Science School were residential, hosted in Farrer Hall, at Monash University. It included all staff of the school and all of the new students. The program for the Orientation Camp included formal sessions, which 'introduced the kids to the academic stuff that they could be learning' (Assistant Principal) as well as 'more pastoral activities' such as learning about the House structure and knowing which tutor group they had been allocated to. The students and staff were introduced to facilities around the University they would have access to, and taught protocols for when they were in 'more specialist areas along the STRIP' (Teacher). Most importantly, the students and staff were given the opportunity to get to know each other.

The very first night we had a bush dance. Some kids from Asian cultures had not really had that experience and they loved it. The quieter kids got into it because everyone was involved. The teachers danced too! There was a warm and happy feeling. The second night, we had a talent quest. It constantly amazes me how talented some of these kids are (Principal).

And

I did not know anyone. I felt quite scared before I came. I have friends at my old school, but when we stayed together here, I think everyone talked to me. I like the people here because we belong together. It felt this way the first day, even when I was scared. Even the teachers belong with us (Student).

After the residential orientation process, the staff and students moved back into a temporary facility whilst the new buildings were being completed. 'We weren't bothered though, because we were all in it together' (Student). Students and staff were asked to reflect upon the value of the camp. The survey data indicated that 'it was a pivotal moment' (Principal) in the beginning of the school as it had enabled students to address a number of anxieties in changing schools and in committing to a narrower educational pathway in comparison with their previous schools. JMSS will run a similar orientation process for new students entering the school in 2011. It is also planned that the 2010 JMSS students will act as mentors for the 2011 students.

One of the strengths of what Peter has done is the transition programs for students, and staff. It is not an easy task, but it has been undertaken in an extremely professional and seamless manner (Monash Academic).

The first generation teachers at JMSS are mindful of the number of new staff who will always be coming to the school, and are anticipating the ways in which induction will be most effectively facilitated and experienced. The plan is to enable as many new staff as is possible to attend the 2011 Orientation camp. More specifically, through the House Structure and Teaching Faculty groups, mentors will be allocated to new staff to support their induction to the philosophies and practices of the school. One of the challenges for the staff who have 'lived the transition and the beginning of the school' is in 'getting everything out of my head and available for others to use and learn from' (Teacher).

We're just starting to talk about it at Leading Teachers' meetings. I've had some thoughts that I need to put together a hand book, where they get to know the nitty-gritties like where all our curriculum is stored, how our unit plans work and how we construct assessment tasks. And, they'll belong to a number of teams, and there will be lots of support through those teams (Teacher).

There are many ways in which teachers and students also work together in teams and clubs beyond orientation processes.

Structured support and learning clubs

JMSS staff, along with colleagues from Monash University offer students highly structured ways in which they can seek further support in achieving success in their studies, or in extending their learning. Within the house structures, there are opportunities to seek assistance from teaching staff, including a number of clubs which draw upon students' passions and interests.

We think that we as staff encourage students to seek help and get feedback and we provide a lot of structured support for them in terms of maths club and revision classes that they ran in science. And leading into major assessment tasks that teachers provide a lot of personal support for kids (Teacher).

Many of the clubs and support structures run in addition to the formal programs of the school. Teachers commented upon the 'longer than usual day' at JMSS, as a result of all the other activities. After the final lesson has concluded at 3.15pm a homework club operates in a small break-out room

on the ground floor of the building. Students are also able to access specialist equipment in order to complete work, and occasionally special interest groups, or clubs, have a 'guest speaker who would not have ordinarily been available during the day or the topic would not have been relevant to everyone'.

A culture of collaboration and collegiality

The staff at JMSS take great pride in the 'culture of the school'. When asked to elaborate on what the culture of the school is, first and foremost, staff refer to the collegiate environment in which they work. They identify opportunities for innovation which occur as a result of the 'safe environment where risk is acceptable'.

I think that part of what makes this school so special, the personalities on the teaching staff in terms of their willingness to try new things and to be open to learning and innovating (Teacher).

Acknowledging and rewarding collaboration and collegiality amongst staff is made explicit and public within the community of the school. During an observed staff meeting, towards the end of a term, a final morning tea was facilitated by the administrative staff of the school to acknowledge the efforts of the leadership team and all teaching staff. The environment is warm, professional and inclusive of everyone present – pre-service teachers completing their teaching practicums and researchers, included. The morning tea was facilitated as a way of celebrating success in staff relationships and activities. Over the term, individual staff had acknowledged ways in which other staff had assisted them by writing what the other staff member had done on a sticky note which was then attached to a community staff notice board.

*Thanks (staff member) for teaching me how to use the media on the interactive whiteboard . . .
(Staff member), thanks for helping me set up this lab and plan the session . . .
It was fantastic to learn about Click View. Thanks for teaching us . . .*

For this staff meeting, all sticky notes were read out to the whole staff, and then placed in a bucket, entering a raffle type draw for two tickets to a movie.

Collaboration and collegiality are necessary aspects of everyday life as all classes are team planned and taught. In interviews, teachers described how different this was from their previous school experiences, and how 'more personal dimensions affect how you teach' (Teacher). In this, several teachers referred to values such as trust and respect as being required within professional relationships.

In other schools, you can go to a planning meeting, and nod your head like you are going to do what has been planned, but then you can do it however, in whatever way you want to because you go back to your own little space and just do it. Here, we work together. We see everything everyone else does – for good and for bad. You have to have a good working relationship with people. You have to know you can depend on them, and that they can depend on you (Teacher).

Commitment to ongoing professional learning

The strong commitment to the professional learning of teachers was evident in how the learning spaces enabled collaboration and informed by the Staff Code of Professional Practice. To demonstrate the seriousness of this commitment, the leadership team have allocated a dedicated time for professional learning and curriculum development every week.

On Wednesday afternoons during the teaching term, the student timetable between 1.30pm and 4.30pm is dedicated to extra curricular activities with 'non-core teaching staff'. During this time, teachers are involved in 'strategic professional learning' (Assistant Principal). The three hour sessions follow an agenda, but always include professional learning moments for the teachers. In some instances, these activities are facilitated by a member of the leadership team. In other instances, and 'more times than others' the sessions will be run by the different faculties or discipline groups.

For example a Learner's Developmental Framework was run by the leadership team.

During our sessions, we focus on a whole school issue, or on making sure we are working towards our agreed vision. At the moment a lot of these meetings are used to talk about moving forward to the next two years when new students and staff come onboard, and we need to develop strategies to really plan properly for this (Principal).

In Faculty-led sessions, staff share hands-on learning activities and experiences which enhance the practices of other staff members. These sessions vary in approach, and sessions may be made up of multiple activities. In recounting a Science team session, the Head of Science commented:

We were struck by how differently everyone was using the spaces at the school. We started the session by sharing the ways that we are using the space for teaching together, and for working students in different ways. It seems to be really paying off. And we know that there are some very talented staff members here, so we wanted to drill down into that a bit more. People were probably taking their practices a little for granted (Teacher).

This indicates how the technology at this school both enabled and challenged teachers to work in different ways. Some professional learning sessions have been dedicated to 'up-skilling teachers who are not necessarily au fait with what can be done'. A professional learning session sometimes begins with a reflection upon a use of technology. Then, teachers will consider how to translate the approach to another classroom context.

We have sharing sessions. Each of our learning areas take turns in sharing how they use the spaces. How they use technology. So for example on Wednesday this week we had rotating sessions. We had half of our staff undertake Click View⁷ for an hour and the other half heard from our English faculty about how to make instructional movies using the software which we can put on the site and I'm really proud to say that the Maths teachers made one. And it's me explaining to the kids how symmetry relationships in trigonometry work, something the kids always find hard. There is now a permanent record of this explanation kids can refer to again and again (Principal).

Similarly, the school promotes the appropriate and purposeful use of social networking media, as well as appropriate search engines. As part of working within a collaborative and supportive environment, the Head of English has facilitated sessions increasing staff understandings of these environments and their potential uses within the learning environment.

⁷ ClickView is designed to assist learning in the classroom by providing a simple and complete solution for watching digital video and other digital media within a school (Click View.com, 2010).

On the ultranet day, when the ultranet was not working, we did a Twitter PD and now we have the majority of the staff on twitter and engaged in teacher learning networks and things. So yeah I think that willingness to work hard and build something and push yourself to keep improving is really important especially in an environment like this due to the fact that we're beginning everything from scratch. But that's part of the challenge (Head of English).

The Principal is extremely supportive of his staff, and recognises a diverse range of backgrounds which 'offer a tremendous richness in professional learning'. In the same way, staff and students look forward to the rich and dynamic partnerships which have emerged, with other external stakeholders.

Rich partnerships with external stakeholders

An exciting and reciprocal relationship has emerged through the development of the JMSS. The relationship between the school, the University and the DEECD is exemplary, and since the beginning of the year, a number of other interested parties have approached these key players to understand the ways in which they collaborate, agitate and work together. This partnership demonstrates shared responsibility, as indicated on the school's website, for the success of JMSS. Whilst there is ongoing support and interest from the DEECD, most of their participation has been in the actual development of the school from a policy perspective. Thus for the purposes of this study, it is important to focus on the emergent relationship between the School and the University.

The teaching staff have all been appointed as affiliate members of the University, to enable their full access to the facilities at Monash. The students have some access to the Monash library and Monash Sports Facilities. They have access to the wifi network, which enables them to work anywhere in the University on their school computing tablets. There have been some limits to the student access due to age and copyright issues, but both the University and the School are looking to resolve these problems.

As previously described, the development of this school was very much a partnership between the University and the DEECD. Monash University academic staff became members of steering committees of the school, and some remain on the School Council at this time. In establishing the school, Monash University also provided infrastructure within their own workload system to enable ongoing support and partnerships between teaching staff and students at the school, and academic staff at the University.

Before the school staff were appointed, academic staff from the Faculties of Education and Science would sit around the table imagining what was possible. That was very exciting. Then the Principal and other teachers were appointed, and the structures of the Department and School life became more apparent, and we all had to think about how we could make this work by all working together. So, we often come in with the big ideas, and the staff ground us. But none of us give in, because we all want this to be great. So, we work very hard to make everything happen (Monash Academic).

There are many opportunities for the school and university staff members to work with each other. The University staff work closely with the school staff to develop curriculum, and often 'take a hands-on role on teaching content' (Monash Academic). The school staff, at the same time see the benefits for their professional learning and students' disciplinary understanding to work so closely with experts across such specialist fields. For the academic staff, there is often a renewed sense of interest in their field in response to the enthusiasm which is evident amongst the younger generation of learners.

We have associate professors, senior lecturers, and lecturers. All the way down from top to bottom. The professor of physics regularly goes across. The associate professor in physics, head of department, regular goes across and does his song and dance act about physics and he has the kids eating out of his hands. It's really great. So much of science is just getting the enjoyment and the enthusiasm across to the students. That's the key issue (Dean of Science).

For the school, curriculum practices are enhanced as a result of the close working relationship between the school and the University. They describe the ways in which their discipline areas have expanded beyond what they have typically taught within schools.

Even at the best school, the VCE curriculum locks you down to Biology, Chemistry and Physics. And there are only a number of Maths subjects you can undertake. By the time our students will be formally in Year 12, they will have already been studying things which are only available in Universities. In some ways, we act as translators or mediators between the theory base and the students . . . although the students love working with the University experts (Teacher).

Learning technologies

JMSS has revisited notions of a paperless school (Hardy, Jones, & Turner, 2003). All students and staff have purchased a portable computer tablet. The computer tablets are the responsibility of their owner, and are required for all lessons in the school. All teaching and learning materials are hosted, using Web 2.0 technologies.

We wanted to make sure that we were matching this building and being very environmentally sustainable. We didn't want paper going everywhere. We wanted to come up with a solution for kids that was portable everywhere, exciting, something that maybe they haven't used before but also could interlink with the university and that's there the tablets have come in. The University have also been trialling them (Assistant Principal).

There were multiple considerations in deciding to adopt one-to-one tablet computing. The cost for some parents, on top of uniforms could be prohibitive. Thus, the school, in partnership with the DEECD and the provider offered parents an option of an upfront payment, or a monthly payment. Another consideration was the device itself. As evidenced in an Intel research report on one-to-one computing in Australia (Bateman & Oakley, 2009), reliability and robustness were significant factors in selecting a device. In other schools, digital innovations had failed when the device was not appropriate for the level of computing which was to be undertaken. It was on these bases that the specific device was chosen. And, from a technical perspective there is a full-time e-learning technician within the school.

The use of web 2.0 technologies to host resources and facilitate online forums is a reasonably novel approach.

Everything is online and it's accessible. We're using Google Apps, even bulletins, course content, interactions, emails, blogs, Google Videos. Now some subjects are using video pre and post to extend students (Assistant Principal).

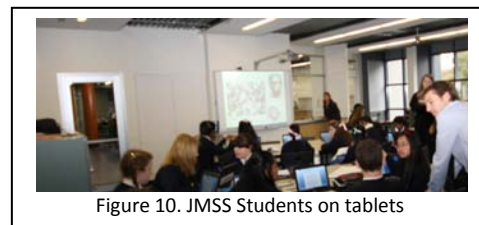


Figure 10. JMSS Students on tablets

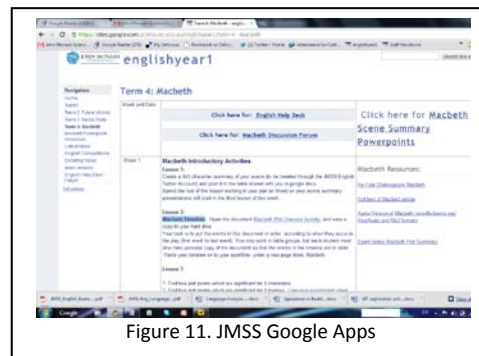


Figure 11. JMSS Google Apps

The technicians program the web 2.0 spaces to enable different levels of access for individuals. Staff have secure Google Docs to upload planning and other administrative documents. In the same way, students also have secure spaces to work. Both staff and students invite others to look at various pieces of work or feedback on work. There are also shared, public spaces, for people to work virtually and collaboratively. Similar to a more structured Learning Management System, there are variety of folders and spaces associated with different units of work, Faculties and house structures. The use of ICTs in this way has left a more visible trace, or documentation of student learning.

So because the online collaboration means that things are not created and then thrown in the bin, they do always have the ability to go back. and we mark their essays, even though the hand write them, the rubrics are all electronic so they can have their rubric emailed to them and save it or upload it onto their personal learning page (Teacher).

Nature and Quality of Learning

There are many aspects of learning which have already been highlighted within this case study, including the ways in which learning occurs within the physical and virtual spaces. The ways in which the Learner's Developmental Framework has already been described as a vision for student learning informs the practices of the school. Other mechanisms such as timetables, curriculum practices and individualised learning plans also influence the quality and nature of learning at JMSS.

The structure

Every day, except Wednesday at JMSS begins with a fifteen minute tutorial group meeting. There are currently four tutor groups per House, and all students meet with their tutor during this time. On occasion, the Head of House will draw all of the tutor groups together into a larger space for a specific purpose.

The timetable of the school operates on a four period day, and a ten day cycle. Each period is 75 minutes in duration to provide opportunities for 'deep learning' (Principal).

The 75 minutes enables lots of activity. It enables you to explore concepts in depth. To take time over things. To construct different activities that you can debrief and then do something different. And so you see all sorts of different ways that the teachers use that time (Principal).

Each morning's tutorial group session is followed by the first lesson. Recess is a recreational interval followed by two lessons and then lunch. One more lesson follows lunch, then students are dismissed. Teaching staff and students monitor lesson start and finishing times as there are no bells nor announcements throughout the school day.

The timetable is coordinated in a way that particular discipline-based classes operate at the same time. This avails all students of shared resources, guest speakers and enables teaching teams to work in creative ways with students. Sometimes, these blocks will involve extended research in large groups, whereas at other times, having all discipline teachers available within a particular year level enables smaller group rotations to take place.

On Wednesday there is no tutor group to start the day. Students go straight to their first class, followed by recess, two more lessons and then lunch. After lunch, students attend 'co-curricular learning'. This time is for students to undertake learning which complements the core learning throughout the rest of the week.

In the co-curricular afternoon all of our students do something different. Probably about half of them do LOTE. We have about 15 languages running. About 40 students do these by Distance Education and we have a teacher who co-ordinates all of that. The students use either the phones or video conferencing to talk with their tutors in at the VSL or Distant Education Victoria.

We have tutors from the university coming in to assist our students. We cover Mandarin, Indonesian, German, Latin and Italian among others.

This year we had two face-to-face French classes and one face-to-face Japanese class taken by teachers from the Victorian School of Languages. This works like a Saturday morning language school. We have signed a MOU with the VSL to help us deliver these two popular languages at JMSS this year, since the school was not able to afford to employ ongoing LOTE teachers in its first year.

The rest of the kids do music, drama or sport. And we have quite a vibrant concert band which practises at this time – they have participated in several school and external events. Other groups of students are involved in guitar tuition and singing. Finally we have a large group of students undertaking sport and another group of students doing drama. We hire tutors to provide instruction at these times.

During this Wednesday block teachers are involved in professional learning and curriculum development.

Curriculum practices

Prior to enrolling, students and their families are advised of the curriculum offerings at JMSS. All of the curriculum practices reflect the Domains and Dimensions of the *Victorian Essential Learnings Standards* (Victorian Curriculum and Assessment Authority (VCAA), 2005) and Victorian Certificate of Education (VCE) Study Designs. At the same time, many of the studies at JMSS far exceed the requirements of these frameworks. There are also dimensions of the International Baccalaureate which are built into the courses at JMSS, particularly in regards to interdisciplinary learning. All learners at JMSS are involved in studies of English, Maths, Science, Physical, Personal and Social Learning, Sport and Physical Education. There is an expectation that students will study a permutation of English, Maths and Science to Year 12 level. They are also enrolled in blocks of study referred to as Creative Studies and Issues Studies. Where possible, inquiry and student-directed pedagogies are utilised, 'even in subjects you wouldn't have thought of trying it' (Teacher). In this section, innovations in English, Science, Maths, Creative Studies and Issues Studies will be highlighted.

English

The English curriculum is taught in isolation, however where possible makes inter-textual references between students' other subjects. At the same time, English genres and the teaching of explicit literacy skills are taught across all studies. JMSS provides opportunities for acceleration in English studies. In some instances, students undertake Units 1 & 2 (VCE) English Literature in Year 10, followed by Units 3 & 4 (VCE) English Literature in Year 11. Alternatively, students choose to undertake English in Year 10, Units 1& 2 (VCE) English or English Literature in Year 11 and then Units 3 & 4 (VCE) English and/or English Literature in Year 12.

English is taught in a dynamic and multimodal way (Cope & Kalantzis, 1999). The Head of English describes herself as having a love of 'all things technology', and where possible technology infuses pedagogies and learning experiences. The use of the Google apps and shared documents has made

the 'drafting and writing process much more collaborative'. In developing the curriculum at JMSS, the teachers have used Backward Design, thinking about where their 'students need to be, and where they start from' (Teacher). The curriculum is often planned through big concepts, such as Identity and Change.

In some respects, and in some schools, vision can be a little limited by the ways that science learners and humanities learners are separated in schools. Spending so much time in open spaces where you are so much part of everyone else's lessons has helped us to see many more possibilities for crossovers (Head of English).

Science

Many of the concepts which organise curriculum at JMSS are drawn from the extensive Science curriculum. It is within Science curriculum that there are the strongest partnerships between the school and external partners. The Year 10 Science curriculum is broken into Core Science studies and Enrichment Science studies. Core Science Studies includes Science in Action (Science in the real world), Physics & Chemistry (the enabling sciences), Themes in Biology and Investigative Projects (student inquiries). Each of the core science studies go over one term.

Students choose semester long studies from the Enrichment Sciences. As part of accelerated studies, students are able to enrol in Units 1 & 2 (VCE) Biology and Physics, however, the other Enrichment Sciences are unique to JMSS. Enrichment Science studies in 2010 have included Nanotechnology, Marine Biology, Astronomy (From Quarks to Quasars), Geoscience (From Ice to Fire) and Biomedical Sciences. In planning for future cohorts, further University enrichment subjects are being investigated.

We don't want to teach Science in the traditional ways. We've got to grab these kids in year 10 and take them on a journey and teach them that science is not all about silos called physics, chemistry and biology, it's not the way real scientists work or construct knowledge. And that's why we're doing a lot of work with the real scientists at Monash and the education faculty so that we can start to break down those barriers (Head of Science).

The design of the Science curriculum, similar to the English curriculum, attempts to develop 'big picture understandings of science in the world' (Teacher). This year, across the core science studies, as well as covering fundamental concepts in the traditional science disciplines, the teaching staff have attempted to develop skills and knowledge in students integrating core ideas in topics such as light, across the major science disciplines.. 'It is often easier to think about biology, chemistry and physics through the different natural occurrences in the world, so it makes sense to kids to link these ideas together under a core theme' (Head of Science). This has been a different way of conceptualising learning for our learners, and has been challenging for teachers also.

Maths

There is the expectation that all students will study Maths up to Year 12. Like English, there are a number of permutations and combinations incorporating studies in Maths Methods (Unit 1 & 2) at Year 10 or 11, and Maths Methods (Unit 3 & 4) at Year 11 or 12, with options also of Advanced General Maths (Units 1 & 2) in order to prepare for Specialist Maths (Units 3 & 4) in Years 11 or 12. There are also opportunities for enrichment Maths' studies. Like the other curriculum areas discussed thus far, Maths at JMSS is highly specialist, but is taught in creative ways. As opposed to developing maths directly from exercises in a textbook, the staff at JMSS, try to make maths learning inquiry based, and 'more than just regurgitating a formula' (Teacher). Upon the opening of the school year, staff began maths teaching with an open ended inquiry. The Maths team experienced some resistance from students and their families to learning which looked and felt different to their previous experiences.

We started with a unit that was purely exploratory which really threw them right out because a lot of these kids just love to do their text book stuff. That's all they've really done before and now we had them drawing pictures of billiard ball paths on billiard tables and trying to find patterns and make predictions, a very different sort of mathematical thinking - we need to do more of it. The parents were wondering what we were teaching them and wondering where the maths was. And you've just got to ride that wave. And hold your ground and keep explaining to the kids why this is good – it helps to develop their ability to think! (Head of Maths).

This 'holding your ground' and explaining why 'working differently' is significant has been important in this area, and there has clearly been a rethinking from the students' point of view. In an observed maths lesson, students were keenly engaged in discussions and theory work around transformations of lines and quadratic functions. Two teachers working together around the room, engaged with students as they attempted to solve quadratic equations. Whereas one teacher explained one method of solving the equation, the other teacher presented an alternative method. As more challenging equations were posed for students to solve, one of the teachers then presented yet a third way of solving the equations. This researcher became quite swept up in the energy of the learning space, and whilst had not attempted this maths for some years, was inspired to attempt the various approaches. The students, as well as being able to apply a theory of formula, were also able to identify the different ways and times when the alternate approaches were most appropriate. With the passion and mathematical knowledge of these teachers, what 'would usually take a whole week to cover, now only takes a session or a couple of sessions at most' (Teacher).

Creative Studies

There are two subjects at JMSS, 'unlike any other units in any other secondary school'. The first of these units is Creative Studies, which explores the nexus of problem solving, creativity, technology and nature. This as one of the units developed in collaboration with academics from Monash University in generating showcase units of study which 'would demonstrate the potential of very powerful curriculum choices' (Monash academic).

During the first semester, students completed a number of short self-contained projects that allowed them to explore how the notions of computing and information processing are highly relevant to all of these areas and how they can allow us to investigate nature from a different point of view. The year began with a study of Virtual Worlds, computer simulations of natural phenomena. The students built computer simulations and visualisations to perform open-ended explorations of complex natural phenomena, such as bushfires and bacteria colonies, and learned how a computer can be used as an instrument of scientific enquiry.

In experiments with the true slime mould *Physarum Polycephalum* the students studied the idea of Natural Computing or computing in natural systems. They explored how even this simple amoeboid organism can solve surprisingly complex problems to optimise its survival chances and discovered that computing is not limited to technological artefacts, but an integral part of nature. The final module of the first semester introduced Acting Machines, robots that can physically interact with their environment. In a variety of projects, the students tackled fun and challenging constructions, from sumo wrestling robots to robots that perform search-and-rescue missions.

The major focus of the second semester was Algorithmic Thinking. Students were introduced to the idea of algorithmic problem solving. The major project of the second semester was the construction of a computer program to beat a human player at Tic-Tac-Toe. Through this project, the students explored what it means to solve a complex problem systematically by means of computation and how a (comparatively simple) program can appear to behave intelligently. This naturally led to lively class discussions exploring the ideas of what computers can do and what they cannot do. On the background of computational theory, these discussions examined questions such as: What does it mean to be intelligent and creative? Can computers be intelligent? Does mathematics require creativity or is it just computation? Can everything be computed? How does human thinking relate to computation?

Though the second semester was certainly challenging, it helped a significant number of students to reach a level of understanding of computation and programming that is normally only expected at introductory university entry level (Monash Academic).

Issues Studies

The second curriculum area unique to JMSS is Issues Studies. It is an integrated studies unit which invites student inquiries about 'issues of world significance'. Learning in this area typically foregrounds knowledge and skills within the Humanities domain of learning. The Issues Studies program was developed in collaboration with the Humanities Faculty of Monash University.

Issues Studies teaches students to examine issues through a range of lenses – scientific, social, ethical, political, philosophical, historic, economic and through notions of place. It is complementary to all of the learning that happens here. We are quite committed to developing ethical scientists as well as knowledgeable ones (Principal).

Some of the studies which have been undertaken this year have focused on Climate Change and Sustainability. In thinking about Climate Change, for example, students have considered the social effects such as demographic distributions, and the ethical dimensions of this world-wide problem. They have also looked at human actions through time which could have contributed to current thinking in this area. In the same way, thinking about sustainability has challenged students to think about key events which have generated change in the world, such as the Industrial and Scientific Revolutions.

This thinking is very important for these students. Often they have come from schools where they have learned the science or the maths or 'the whatever' very thoroughly, but a subject like this helps students to ask the big questions about why things happen, or why things should happen. It's like a deeply philosophical study which helps them to also think more critically about the value of scientific and other knowledge themselves (Monash academic).

As a result of their collaborative studies of a specific issue, students are encouraged to pursue an in-depth and extended independent study. Through these studies, students identify the complexity of issues around them, and in turn recognise the complexity of applying solutions. This aspect of

deeply reflective learners who are able to make connections within their learning is also valued within the cultivation and negotiation of individualised learning approaches.

Individualised Learning Approaches

JMSS prides itself on its ability to cater for individual students. The ways in which students negotiate a pathway for their studies from the time they enrol in the school has been previously identified. The individualised approach to learning is important, especially given all of the variations of enrolment which are possible, as described within the curriculum. At JMSS, individualised learning approaches are developed and subsequently enacted.

There is a formal arrangement which is negotiated between the House tutor, the Head of House and the student. Staff at JMSS take enrolment data received for each student very seriously in planning their curriculum and also managing their wellbeing. In their application for a place at the school, the students provide significant documentation of their previous schooling experiences. They also participate in externally facilitated examinations to demonstrate their capacity for maths and science. Within the school, there are common databases which enable teachers to access students' performance data, including attendance and academic achievement. Staff regularly provide online feedback and collect artefacts of student learning from the online technologies utilised within the school.

We are learning to work with the amount of data we generate here. We already have a great deal before the students start, but given the way we work, we are continually amassing more and more. And, we are developing a very big picture of each student, so that we can counsel them in how to work more effectively, like whether they should try to get a bit more balance between study and leisure (Teacher).

Teachers describe the ways in which they know their students and are able to advise them on their next stage of studies. During the orientation process at the beginning of 2010, students began to record their personal learning goals. They use Google Docs to develop their goals, and then begin to plot ways in which they can achieve their goals. The goals are both short-term and long-term aspirations. When it is time to discuss this with the relevant staff member, they share a document or give permission for someone to read what they have said. With specific feedback and approvals, the plan can be implemented.

We attempt to individualise the program for every student. They will always have the chance to adapt their plan as things change, but it is important to meet regularly to ensure that we are all working towards the same outcome. That is to give our students the very best chance of being the best person each of them can be (Teacher).

Impact and Effectiveness

Part of the challenge in discussing the impact and effectiveness of the school is that policies and practices are still being developed. For this reason, we would describe this school as being in a transition or an implementation phase (Blackmore, Bateman, Loughlin, & O'Mara, 2010, p.4). Issues of sustainability and innovation will arise as students progress and are enrolled in years 11 and 12. The following comments about successes and challenges are based on the first 10 months.

The leadership team of JMSS along with their University partners have much to celebrate at the beginning of JMSS' life. And, at the same time, it is the leadership itself which is celebrated through

the successes of this innovation. Through the partner *Staff Code of Professional Practice* and the *Learner's Developmental Framework*, there is a clear, yet negotiated vision of the school which permeates every aspect of planning for teaching and learning. The 4 Pillars have been a useful mechanism for organising thinking about the work of and inter-relationships between the staff and students within this school.

The physical learning spaces have had a significant impact on the staff, who have come from more traditional settings, creating new opportunities for collaboration between students and staff, staff and staff, and students and students. Staff have taken great pride in recalling the ways in which spaces are reconfigured for different purposes, and how their own practices have been challenged in not defaulting to 'talk and chalk' approaches. Reflection on the professional learning has occurred through simply 'being immersed and living within the open spaces'. Staff members talked about listening to what and how peers were teaching, and their availability to students as a result of planning within the open spaces.

The common spaces have enabled students to interact both formally and informally. Their 'keenness to be here well beyond the end of the day' is indicative of their engagement and sense of belonging. Preliminary student survey data indicates that students are extremely satisfied with their school environment, and the programs they are being offered at this school.

Furthermore, there is overwhelming evidence of commitment to individual successes. Two students have withdrawn their enrolment and returned to their schools of origin, primarily to pursue curriculum options not available at JMSS. Prior to their departure, the students were provided with considerable counselling, ensuring that they understood the magnitude of the transition. Staff have shared their concerns about those at risk emotionally, or their concern that individual families were facing financial hardship and looked for viable resolutions. Teachers are involved in the negotiation of individualised learning approaches.

Staff interaction, collaboration and support is a strong commitment of all staff members. There is a sense of enthusiasm and trust amongst the staff, as evidenced by the number of teachers who describe risk-taking as being encouraged by the leadership team, and a sense of the safety and confidence in their capacities as professionals to make bold choices and take chances. The staff interdependently work for the success of their students, and collaborate in purposeful ways to provide provocative and engaging curriculum opportunities for students.

The Monash University environment is rich for students who are passionate about science and maths. The location of the school in the vicinity of the STRIP provides students with access to real-life science applications which are considered cutting-edge internationally. The challenges of limited library access and other facilities seem insignificant given the magnitude of the resources within walking distance of the school. Having said this, the capacity of the school staff in generating resources and innovating ways that resources can be accessed by and for students is what makes this limited access to the University library manageable.

There have been challenges experienced by JMSS. Having now moved in, gaps in design have been realised with a lack of change-rooms for sport and Physical Education, and performing arts spaces, especially for Music. A lack of storage space has meant that storage space is at a premium. The misunderstanding about a shared library has meant that JMSS will now have to grow a library of sorts, which they had not anticipated.

Concluding Comments

The Innovative Learning Environment at John Monash Science School has, in a short time made tremendous gains in innovating in predominantly traditional discipline areas. The innovative uses of technology and flexible learning spaces has generated rich and interactive learning for students and enhanced effective team-teaching, student and teacher learning and action-based inquiry. As a senior school, JMSS provides rich data and possibilities for the creation of innovative learning environments in other contexts and for many stakeholders.

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