“WE ARE NOT WHAT WE ARE”*: 
MATHS IN THE TIME OF VELS

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On the 30th August a conference dealing with Girl’s education and leadership was held at Melbourne Girls’ College. The keynote speaker, Di Flemming, then Principal at Kilvington Girls’ school, began her speech by quoting from an article published in the Australian newspaper.

It is my understanding that girls who are 10 will enter the workforce in a world where professional positions are not yet created and technologies not yet designed. It is impossible to put a face on the future, but not impossible to predict skills necessary not only to cope with it, but to direct it. (The Australian, date unknown)

After issuing this challenge to educators she called for a redefinition of what teachers were on about. She claimed that schools were about learning not teaching and that the school of the future would not be about subject teaching but rather about developing the skills to cope with a rapidly changing world.

It is no longer impossible to put a face on that future because Flemming’s future is our present, but the future of students who are learning in our classrooms now is just as impossible to characterise. Flemming argued that students do not need knowledge but they need to be able to work in teams. They needed higher order thinking skills and problem solving skills and they needed to be computer literate. School ethos and curriculum must be based on providing a co operative learning environment with opportunities for students to solve problems co-operatively. Reich asks us to create decision makers who identify and solve problems, network and analyse. Mayer competencies: Collecting, analysing, communicating ideas, planning and organising activities, working in teams as well as leading, using mathematical concepts, solving problem in an interdisciplinary framework is the responsibility of the modern school and necessary for students to cope with the emerging future.

This is the ethos of the new curriculum change: The Victorian Essential Learning Standards (VELS). It asks us to redefine what is essential for students to learn, therefore what is essential for educators to teach. For VELS, learning is deeper understanding of the materials and processes, not just absorbing and regurgitating for the assessment tool, whether it is projects or tests or exams. Most of us have read the Maths VELS and many have begun to write units. Maths and English teachers have to report against the VELS standards in 2006, but at the time of writing the Department had not released information about how we must do this – which is making us nervous. One of the big questions for us, then, is how to implement the VELS. This is an issue for Curriculum co-ordinators in all schools because the ethos is cross disciplinary and is skill based. However, the broad implementation of VELS is not the subject of this paper.

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Professor Alan Luke calls it the “New times”. Luke makes another important point, and I quote:

The identity and generational issues aren’t solely about our students. About half of us are thirty and half are fifty-five. We are a workforce with an average age in the mid-40s struggling to keep the car that has been bequeathed to us on the road; struggling to run education systems and teaching systems across this country that are composites of curriculum and assessment policies and practices latched together in a sometimes ad hoc fashion over the past 30 years. So not only are we being asked to redefine what and how students are learning but how we see ourselves and our subject.

One of the good things about the VELS is that it emphasizes learning rather than teaching. It acknowledges the leaps forward in knowledge about how kids learn and understanding of the ways the brain works. It does not compartmentalize knowledge. It emphasizes the teaching of skills. It directs teachers to student-centered learning and is based on knowledge of different learning styles, continuing and extending the work of the Middle Years reform agenda.

The difficulty for teachers is that they are being expected to implement curriculum change in the context of schools that are still set up for traditional teaching and learning using resources that are designed for a traditional classroom. Also Professor Luke’s comments have already been quoted: we may have to change our mindset about how our subject is structured and how it works. Also, what happens when the VELS meets VCE content, which is mandated, driven and assessed by exams and SACs. In a climate where the worth of a school is judged by the public in the form of league tables devised from exam results, questioning the VELS is valid. Students’ expectations and parent requirements cannot be ignored.

For classroom teachers there are other more pertinent questions. The VELS reform may force us to change how we look at Maths and will definitely affect how we teach it. How will we teach maths? Can we continue to teach in the traditional manner? Can we think about or perceive what we do in the same way? How do we deliver content? How do we know how students learn maths? In fact, can we really say how students learn maths in our classroom now? Do students develop adequate understanding in our classrooms now, or do they grasp just enough to perform on tests, and exams? Also can Maths teachers use some of the teaching strategies used traditionally by other subjects, for example Language Arts? In one simple answer to these questions, we do have to change pedagogy used to teach maths. We may have to change the way we see our subject as well as the way students perceive it.

Middle Years reform has had a huge impact on our classroom teaching. It has changed our perception of what we do and how we improve learning outcomes for students. The learner is the centre of our planning and strategies and different learning styles are acknowledged, using Multiple Intelligences to set learning tasks. It is the expectation that teachers will plan lessons with the engagement of the learner as a key goal. Further, Hermann’s theories of whole brain learning are used in many schools. The various taxonomies have resurfaced as guides to setting learning experiences and assessing student achievement. Di Flemming’s prophetic words are enshrined in the emphasis placed on student development of higher order thinking skills and highly literate ICT skills. Also, Mayer’s set of competencies required by a reasoning, functional individual in a changing world underlie the teaching in a Middle Years classroom.

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Let us look at a Maths lesson that demonstrates a Middle Years approach to teaching, then I will discuss how this needs to be developed even further to reflect VELS ethos and practices.

**An illustration of the middle years approach**

The lesson was on Trigonometry: Geographical applications, a topic I knew would not interest most of my Year 10 students. Also, it was being tested across the year level so they had to cover it. They had to know about calculating distances on the earth’s surfaces, latitude and longitude, directions and bearings. They were generally a well behaved class who had all experienced some degree of success in Maths in the past and if I had simply modelled the skills on the board and set work out of the text book they would have done it without complaint. I decided to create tasks that covered the Multiple Intelligences and Hermann’s Whole Brain learning scheme and I set up stations where each group of students had to complete a task. They worked in cooperative groups of four. I used three periods of teaching time. The tasks were as follows:

1. **Definitions and mathematics.** Reading the text book and completing exercises.
2. **International time zones.** Students were given a map of the world with time zones on it and completed written activities.
3. **The Butterfly.** Students read the story of the Butterfly by Robert Vaughn Carr. This story is about a butterfly beating its wings and the wind becomes gradually bigger and bigger until it returns as a cyclone. Students also had a map of the world and they were asked to highlight the geographical place names and use contextual clues in the story to plot the path of the wind around the world.
4. **Mission Possible: A virtual flight.** Students used computers and Microsoft Atlas programme to fly a virtual plane from Melbourne to Invercargill and back. They also had to use the programme to find out the latitude and longitude of Ouagadougou and of which country it is the capital. Successful flyers won a Freddo Frog.
5. **Orienteering.** Students used a map of the school to navigate from the classroom to the cafeteria and back using 10 changes of bearing. They plotted these on the map. When they had finished all the stations, they filled out an evaluation of what they had learned and recorded which task they enjoyed the most in a learning log style task. The experiment was successful. All the stations were preferred by at least 4 students and I gained an excellent snap shot of the learning styles of the class. The virtual flight was the favourite. They performed as expected on the test. One boy claimed to have learned one important piece of knowledge. He now knew where Ouagadougou was.

The VELS website provides an assessment and reporting resource and a teaching and learning resource. This is common to all domains and strongly suggests that teachers use the pedagogies and strategies listed.

VELS curriculum takes different learning styles into account to achieve increased student outcomes, but the greatest change is in the concepts of assessment of learning. It is no longer enough to test student learning by tests, projects or exams administered at the end of the unit. VELS provides a broader range of assessment tools and a wider definition of assessment itself. Teachers are asked to assess for three broad purposes in the Guide to assessment document on the VELS web site. These are:

1. Assessment for learning which provides information on student knowledge, skills and behaviours to inform the next stage of learning.
2. Assessment as learning which provides feedback and opportunities for student reflection and/or self-assessment to support future learning.

3. Assessment of learning which provides information about what students have learnt in relation to the standards.

Assessment tasks to support the Victorian Essential Learning Standards should provide students with an opportunity to display the knowledge, skills, understanding and attitudes they have developed and motivate them by recognising what they have accomplished. They should be a combination of authentic, summative and formative assessments to encompass the integration of knowledge, skills and behaviours. Assessment is a mix of summative assessment of learning to determine what the student has achieved over a period of time and formative assessment to inform the next stage of learning that will occur.

These assessments are part of the teaching cycle and not part of grading. Even summative assessment which is made at the end of a unit and is made against the standards, broad sets of skills such as the Mayer Competencies and set goals of a unit can be formative or diagnostic in nature. Teachers should provide authentic real world tasks characterized by meaningful product, performance and process in which students can apply their knowledge and demonstrate deeper levels of learning and understanding. Learning, creativity, initiative and risk taking should not be curtailed by assessment driven activities.

Students should be aware of the criteria for assessment and be involved in its development and evaluation. It is suggested that Teachers use rubrics, student portfolios, observation of student development and recording anecdotal evidence to indicate the kinds of strategies that teachers and students need to apply to improve learning during the course of a unit.

Along with a wider range of assessment tools and tasks which cater for different learning styles, teacher record keeping will have to change. Schools will need to develop proformas to record observations of anecdotal evidence, carefully worded rubrics which can compare products which will look different, and ways and means of evaluating student learning occurring throughout the unit. It is the clear intention that student input is required in the development of learning activities and the assessment of these tasks. Also teacher judgements and assessments need to be passed on the next teacher the following year.

VELS principles

Now the above is learning based on Middle Years principles, but it differs in some key aspects to VELS learning because there was no negotiation with students. In the VELS world, the Maths and SOSE teachers would have collaborated closely and even scheduled “Geomaths” lessons for the class. The teacher would have observed students closely as they worked recording formative assessment notes, and the preferred learning styles would have been no surprise. The tasks might have been suggested by the students and certainly the ICT component would have been more interesting, perhaps comprising digital literacies and new multiliteracies. Again I quote Professor Luke:

We are actually at an historical juncture which is unprecedented in the last century, where the kids know more about the technologies than we do – where we have to negotiate with them at the very moment where their mastery of practices and, indeed, mastery of new forms of reason with some of these new technologies bypasses ours.
The test would have been only one form of assessment. Perhaps one of the students might have redesigned the pages in the textbook or written a PowerPoint presentation for another class on the topic. Or, when we looked at what students need to learn, would we have taught the topic at all?

As I have mentioned earlier, the cross disciplinary aspect of the VELS is the most exciting and the most challenging for educators. When we did our Diplomas of Education, we were trained to teach Maths and we mastered our methods. We believed in the mantra that Maths was sequential, and that mastery of basic skills was the go. Our responsibility to students was to cover the course set down in the textbooks and prepare them for glorious results in the VCE. We knew that some students thrived on this regimen. Other dropped Maths as soon as humanly possible. These were called “Humanities students” and they possibly had English Literature and Arts course to fulfil their academic ambitions, so it didn’t matter too much. But what if these assumptions were not true? What if Maths teachers could use strategies more often connected with the teaching of language arts? What if students, engaged in what they are learning, could understand Maths without doing the hours of textbook drill? VELS curriculum reform asks us to open this debate.

The first point I wish to make is that teachers have access to a wider range of strategies to teach Maths and for students to demonstrate their learning. VELS emphasises the use of learning journals and portfolios and I would like you to consider how these tools can help students understand Maths. Every human being learns to speak and understand his/her mother tongue, however not everyone learns to do mathematics well. Teachers and parents expect students to succeed in learning to talk, but not necessarily to succeed in learning to do mathematics. Natural language and mathematics share some common characteristics, for example: a system of symbolic notation, a complex syntax, a perceivable connection to the real world, and representation of abstract concepts. Thus a fundamental question arises: Why does a child learn one language without the difficulty involved in learning the other?

The two most interesting and provocative articles, if we are considering modern classroom practice, are (a) Mathematics and Language: The experiences of the EMIC and Key Group, by Ian Robinson (in Davis & Hunting, 1990); and (b) Mathematics and Learning: Reflections on Students using Mathematics Journals, by Andrew Waywood. Robinson discusses the work of a group of teachers who applied the holistic language learning approach, which includes Cambourne’s (1884) seven conditions of learning and “process learning” to mathematics. Andrew Waywood presents the technique of reflective writing in mathematics journals as a tool to help students to “see the world mathematically” and so, to enjoy mathematics. Robinson’s thesis is that we must consider the possibility that if children begin writing with invented spelling and gradually evolve acceptable adult forms given time, practice, engagement and the right forms of support and encouragement, then a similar process may occur in mathematics. Moreover, by learning in this way, the children’s understanding is firmly rooted in their own experience and language, so there is a well developed concept model when formal and abstract mathematical language is introduced (Davis & Hunting, 1990). Robinson’s evidence comes from the work of the Key Group Teachers, who applied the work of Cambourne to the teaching of Mathematics and the Exploring Mathematics in Classrooms course which developed around the same time. He warns teachers to have a very clear idea that mathematics is the gathering, grouping, ordering and manipulation of information about size, shape, number, quantity and time, and the ultimate purpose is to
achieve the representation of abstract thought. (D&H p. 93) However, the road for the
learner is via exploration and problem solving under Cambourne’s seven conditions of
learning.

Cambourne’s principles
Cambourne has become a very influential theorist in the area of language learning since
he delivered his 1984 paper on how children learned to talk. From his observations of
children learning to talk, he outlined seven conditions necessary for the successful
learning of this skill.

1. IMMERSION: Children hear meaningful spoken language in whole contexts from
   the day they are born. From this they learn the meanings and rhythms they will
   need to talk.
2. DEMONSTRATION: The child hears thousands of models, examples or
demonstrations of spoken language and the conventions of language are finally
   used.
3. EXPECTATION: Adults communicate that they expect the child to be successful.
4. RESPONSIBILITY: Children make up their own mind when they will learn each
   convention and adults allow them to learn at their own natural rate.
5. APPROXIMATIONS: Young learners are not expected to display full blown
   competence from the beginning. Adults accept that approximations are temporary.
6. EMPLOYMENT: Young talkers are given plenty of opportunities to use their
   language skills in a safe and nurturing environment. Young talkers talk when they
   are by themselves, because the activity is completely satisfying.
7. RESPONSE: Every small advance is responded to enthusiastically by significant
   adults who often repeat what the child has said using conventional forms,
   providing yet another demonstration!

Robinson then posed the question “To what extent can Cambourne’s seven conditions of
learning to talk be applied to the learning and teaching of mathematics?” The Key Group
teachers found that the seven conditions could be applied like so:

1. IMMERSION: Children are immersed in a mathematical environment, but are not
   as aware of it, for example, shopping, time-tabling, measuring, cooking, playing
   and scoring games. Make them conscious of it and encourage children to
   logicomathematise their world.
2. DEMONSTRATION: Teachers need to model mathematics being used in many
   useful and meaningful ways, involving children in mathematics that make sense
   in the present in their own lives.
3. EXPECTATIONS: Convey to children that they can do mathematics, not that
   they cannot.
4. RESPONSIBILITY: Not only do children take on responsibility for their own
   learning, but the notion of teaching mathematics in rigidly sequenced packages
   may be jeopardised. In learning to talk, the learner decides which demonstrations
   he or she will take up as his or her own. In the typical classroom, the teacher
   decides what will be learned and in what order.
5. APPROXIMATIONS: teachers found accepting children’s “wrong answers” a
   very difficult issue, although a solution was found, by reducing the role of the
   teacher as the ultimate authority.
6. **EMPLOYMENT**: Opportunities for using mathematics as a tool for understanding and manipulating reality suggest plenty of problem solving, investigations and group work.

7. **RESPONSE**: Group work and problem solving allows the teacher to deal with approximations by reference to the collective wisdom and experience of the group. (Davis & Hunting, 1990, pp. 87–89)

The Key Group teachers successfully transferred the Conference approach used with creative or “process” writing to mathematics. Three aspects of the process approach seemed to transfer readily. Firstly teachers took on the notion that children should be in control of their own learning, working on group projects and problems. Secondly, they accepted the idea that children would gain a better understanding of mathematics by talking about it and writing about it in various ways. Group work allowed the children to talk and explore concepts together, and so learn. Thirdly, conferencing in mathematics was as useful as conferencing in creative writing. The teacher could find out where the children were at in mathematics as well as English. Explanatory and reflective writing were vital for the learner and the teacher.

This leads me to my observations of my niece. She was an indifferent student of mathematics, achieving consistently lower results in class than her peers and registering an increasing dislike for the subject. She did not know her tables by the time she was halfway through Grade 3. Her home environment was language rich, and she excelled at all forms of language studies, but the environment was not equally overtly mathematically rich. She demonstrated understanding of complex abstract mathematical concepts in terms of her world and natural language.

A clear example is the connection between rollerblading and angles. She had been completing some homework one night when she suddenly leapt up and said:

*There really are 360 in a circle. When you do a “360” on your blades, that’s a circle. Big circles. Little circles. They all have 360. (She picked up a coin.) This has 360. You could cut the world in half and it would still have 360.*

She put on her rollerblades and demonstrated 90 and 180 degree turns, accompanying each one with a mathematical explanation. Her mother and I praised her and encouraged her to continue. Our response was important in the process. Cambourne’s seven conditions are all here, and the learner is learning. She is on the way to a formal and abstract representation of a mathematical thought founded in well understood concepts. She is enjoying exploring mathematics. She is engaged!

**Use of journals**

Waywood encourages the use of learning journals and observes that his students look for meaning in mathematics and expect that mathematics will explain things in the world. He classifies student responses in their journals into three types: “narrative”, “summary” and “dialogue”, which is the highest level of the taxonomy. (Davis & Hunting, 1990, pp. 53–54). *Narrative* means reporting what happened in the class. The basic feature of *summary* is the recognition and ordering of important ideas, using appropriate examples, precise and thoughtful annotation or commentary. *Dialogue* occurs when a student actively interrogates the world and mathematics in order to make sense of it.

Waywood gives examples of each type of writing. He notes that in nearly every case students progress from narrative to dialogue and deeper mathematisation of their world.
view, but the development is not necessarily linear. He reported on his use of the following aspects of his classroom:

1. Students are encouraged to read articles in mathematical journals
2. Students are encouraged to comment on their own errors.
3. Students read through the whole chapter before they do any problems and write down their questions. They review their learning at the end of the chapter.
4. They explain processes in their own words, transferring their mathematical understandings in to understandings in their natural language.
5. They ask questions. Waywood identifies questions of understanding, wonder and probing the concept.

I expect that students often make statements similar to Louise’s in a classroom like this that satisfies Cambourne’s seven conditions of learning beautifully.

The work of both these writers is based on actual classrooms and real students and has a basis in practice. Both writers tackle the problem of the differences between Mathematics and Natural Language, but ultimately highlight the positive benefits of the relationship rather than the overwhelming obstacles. Waywood argues strongly for the success of his reflective journal in teaching his students to view the world mathematically, but he admits that some technical knowledge is necessary for the students. One would hope that in the demonstrations and conferencing sessions used by the Key Group teachers, that the Tables and basic processes of addition, subtraction, multiplication and division covered, or the students would have limited ability to deconstruct and construct numbers at all. Some concept of algorithmic process has to exist before the learner can try it out. Observation of Louise’s progress in mathematics argues strongly for Engagement and understanding processes in terms of the learner’s world as prerequisites for a meaningful understanding of concepts. Implementation of these learning practices have serious ramifications for the traditional mathematics classroom and the sequential view of Mathematics learning.

**Thinking mathematically**

It is my ongoing pleasure to organise Maths Talent Quest in my school. The Maths Talent Quest encourages students to construct a hypothesis which they prove mathematically. Students conference with teachers who become a resource to enable them to explore their mathematical question. It satisfies middle years needs and models VELS ethos. To come up with a hypothesis they need to look at the world mathematically, as I pointed out in my opening address to the National finals last year. Four examples of how this is done follow.

- First, a mathematician sees the shapes, relationships and laws of their every day world in terms of mathematics. At La Trobe University in Victoria the Agora where students meet at lunchtime has a large circular lawn inside a square. The groundsman would notice that the grass needed cutting. The tired student would hope the grass wasn’t wet. The mathematician would be seeing so much more. Similarly, the façade of Federation Square has tessellated geometric shapes. The mathematician would be doing more than admiring the colour schemes. Photographers would notice the qualities of light, composition, contrast and depth in Manray’s mathematics series. The mathematician would understand that Manray was trying to represent powerful underlying natural laws in visual form.
• Second, as we have seen, Mathematics is a language and as such can be learned and used to express meaning. Swift called it “the music of the spheres.” An equation can sing to those who understand the language and to our students who have not turned their volume control to zero.

• Third, a mathematician is a question asker, a code breaker and a person who recognizes and quantifies patterns. In a “Beautiful Mind”, there was a scene where John Nash is writing his calculations on the library window. As he stares at his equations, the solution leaps out of the jumble of numbers and signs. In another scene, his mind sees a pattern in the stars. The main character in Haddons, “The Curious incident of the dog in the Nightime”, loves the certainty and predictability of the pattern of prime numbers. The author numbers all the chapters only as Prime numbers.

• Finally, the mathematician is an investigator and a researcher who knows where and how to look for answers to questions he has posed himself. He knows the appropriate language in which to express his findings.

The Maths Talent Quest encourages development and expression of the qualities that turn students into mathematicians. The Maths Talent Quest achieves this feat because participation gives all students the chance to see mathematics in the world around them.

Let us imagine a typical Humanities student who has not achieved success in Maths and does not like it. Let’s give that student an experience to force the wonder of mathematical questioning upon her. Say, for instance, that she climbs the Sydney Harbour Bridge. When she reaches the top, she realises that she can see to the Heads, Homebush Stadium, and other landmarks. She wonders how far away they are. What else is visible? How can you work out the distances? Also having thought the Bridge was a half -circle, she realises it is not. There are flattened bits and different gradients in the curve of the span. With a bit of a shock, the student realises that she is seeing an experience mathematically. Mathematical questioning has been initiated. This student is ready to become a mathematical learner and participate in the Maths Talent Quest. Our humanities student comes down off the Bridge with a new perception of the world, a lot of questions, a wonderful embryonic investigation and inadequate mathematical skills. Her teacher will mentor her and equip her with an understanding of trigonometry and the theory of equations of curves. So instead of going home and rereading a novel, the student is mastering complex Maths because she wants to and needs to. She is also confident that she can do it.

The Maths Talent Quest encourages the student to investigate some aspect of mathematics that interests them. Because it is important to the student, commitment, focus and real learning occurs. The Maths Talent Quest encourages safe risk taking because teachers mentor students and teach skills and concepts they will need to complete the task. The Maths Talent Quest has provided successful student learning, effective teaching and broken down the urban myth that Maths is hard, irrelevant and boring. The Maths Talent Quest has established the truth; mathematics is alive, enjoyable and within everyone’s reach.

**Conclusion**

This is what VELS Maths looks like. This should be what is happening in your classroom. VELS is not asking you to trade the old car in. Students still need basic skills and
understanding of processes, but there are newer models that you can use for daily travel not just for special occasions.

References

AAMT STANDARDS: 3.1, 3.2, 3.3

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