Summaries and Questions from the

STEM Roundtable Discussion

October 19, 2016 (Deakin University, Burwood)

This document summarises and condenses many of the main points made at the recent STEM Roundtable Forum as Deakin University, Burwood. Along with the summary of participant responses (generated from 7 small groups), some additional questions posed by each group have been included. An attempt has also been made to identify any obvious themes that emerged from the collective discussion, separate from those signalled by the four key questions.

QUESTION ONE: **What are the key drivers of the STEM curriculum agenda?**

External/Structural/Systemic drivers-

- the role of funding bodies, state and federal
- state and federal policies
- inherently political agenda (eg role and controversies around Chief Scientist)
- need for increase in multi-disciplinary research endeavours within universities
- the interests of business and industry and demand for labour and skill sets ('the economy')
- need to keep stimulating innovation and entrepreneurship
- imperatives of real-life contexts
- international mechanisms, regulations and competitiveness (OECD, PISA, TIMMS)
- skill sets for small scale and niche industries (eg in manufacturing, micro-businesses)
- curriculum reform driven by top-down approach from authorities

Internal/teacher/principal/school-based drivers-

- need for investment into STEM spaces in schools
- enlivening and enhancing engagement (and hence retention) at Yrs 11 and 12
- developing 'STEM specialists', as there are maths and science specialists, even at primary level
- need to develop flexible and critical thinkers and problem-solvers; reasoning skills;
- importance of a shared language
- greater emphasis on building sets of skills and experiences vs knowledge (eg. new Chinese STEM curriculum); STEM skills complemented by soft skills;
- measured creativity

- support from school leadership
- need for increased embrace of interdisciplinary approach
- need for more input from students
- need for voice of professional voice of (STEM) teachers to be heard more (problem of teachers as receivers rather than drivers)
- importance of developing metacognitive skills in students
- need to develop scientifically literate citizens
- anxiety: fear of falling behind

Emergent Theme/s-

-Tension between pressures and imperatives coming from external agencies/authorities/drivers, and those operating from within schools.

<u>Additional questions raised</u>-

Is passion (in teachers) a prerequisite for developing and implementing a STEM curriculum successfully?

To what extent is the neoliberal political agenda dictating terms to the formation of STEM policies?

What can we learn from, and complement, STEM activities in other countries?

How to reconcile tensions between high-stakes international testing regimes, and the benefits of open-ended inquiry in STEM work?

To what extent is the STEM curriculum agenda dominated by white, middle-class, male hegemonic thinking and values?

How can social justice be incorporated in the STEM agenda?

How dominant is the English language in STEM thinking, and what are the consequences of this?

How do we rebalance the dominant Western view of STEM and embrace other perspectives, especially indigenous knowledges in Australia?

QUESTION TWO: What are the productive possibilities opened up for enlivening curriculum in the STEM subjects?

- stimulating greater appetite for interdisciplinary teaching and learning
- new groupings, synergies and partnerships/collaboration between communities, schools, industries, government, etc
- increasing flexibility in school timetable
- reforms in initial teacher education
- responding to industry demands without compromising the integrity and other imperatives driving STEM development
- project-based learning and problem-based learning
- strengthening the link between democracy and education by ensuring choices are always built into learning opportunities for students; children posing their own problems to investigate; greater student self-expression
- authentic learning for realistic maths (and science) education
- increase focus on learning process (and its inherent pleasures) vs finding right answers
- incorporating more of students' emotional responses and increasing their sense of agency
- developing elective units
- fleshing out in more detail the relationship between curriculum, industry and work
- differentiating technical skills from science skills
- clarify role of training sector (TAFE) in STEM development
- respond to fact that all STEM teachers are teaching out-of-field to some extent
- develop more capacity for delivery of STEM curriculum online
- developing skills for communicating with each other
- formulating more curriculum based on local questions and issues (de-centralisation)
- increased opportunity for authentic inquiry

Emergent theme/s-

-The STEM 'moment' is providing many challenges, suggesting new approaches to established ways of teaching, learning and conceptualising curriculum

<u>Additional questions raised</u>-

To what extent can government and industry be trusted?

How can the curriculum be enlivened to enhance students' wellness and learning?

QUESTION THREE: What are the challenges and opportunities for science and mathematics subject disciplines?

Challenges:

- potential dilution of subject-specific knowledge
- need for time to develop innovative STEM projects in collaborative teams
- deciding who is responsible for, and then developing an appropriate STEM pedagogy
- developing appropriate assessment measures for STEM learning
- ensuring teachers have enough (combined) content knowledge to properly teach STEM
- establishing, and then modelling, good STEM practice
- finding ways to respond to external drivers (eg in Germany, industry has its own assessment procedures and is also a major source of funding)
- countering biases (eg NAPLAN focus on English and Maths only)
- ensuring that the 'big ideas' in specific disciplines or curriculum areas are not lost
- need to make STEM learning a social practice as much as possible
- potential of high-stakes testing regimes to constrain STEM possibilities
- dominance and infiltration of global publishing powerhouses like Pearson
- finding and maintain a balance between the disciplines, especially engineering and technology
- need for adequate teacher professional learning, beginning at pre-service stage
- permitting adequate professionalism of teachers
- developing a shared vision between external agencies and teachers 'on the ground'
- providing enough flexibility within the school system for STEM delivery, especially at upper secondary level
- developing transferrable skills eg scientific inquiry, critical and creative thinking
- developing STEM programs that are sustainable
- need for awareness that a focus on skills can turn children off learning maths
- need to develop an understanding as part of students' funds of knowledge for living
- ongoing challenges and impediments generated by the performativity culture for teachers
- finding a balance between traditional and innovative modes of assessment
- need to find and maintain the human focus
- balancing depth of learning with adequate curriculum coverage
- change must be wholistic and systemic, rather than just piecemeal
- obstacles inherent in traditional structures of schooling and curriculum
- preserving epistemological heterogeneity
- maintain enough humility to work in this new space (also an opportunity?)
- resistance to change
- parent (re)education about STEM
- existential threat of moving from security of individual knowledge base to the transferrable skills of interdisciplinarity
- potentially disruptive student behaviour-messy, chaotic, boisterous

Opportunities:

- having teams with complementary skills, emotional intelligence and shared vision
- recognising potential of STEM to enliven learning in traditional discipline areas like science and maths
- re-direct excess of PhDs into schools
- benefit of expertise from teachers who come from industry
- make more of science as human endeavour in the curriculum
- migrating from a discipline-based model to a thematic-based model
- making science about the future as well as the past
- encouraging more citizen science
- 're-branding' science and maths in more positive ways to (re)engage students
- experience science and maths with greater authenticity in STEM rather than textbook transmission
- capturing commonality across disciplines
- establish what is special and particular about STEM
- bringing industry, science centres and research facilities into the classroom

Emergent theme/s-

-STEM is generating fundamental shifts in the teaching and learning of science, maths and related subjects. These shifts create accompanying tensions, revolving centrally around the move towards the breakdown of traditional subject disciplines and the move towards greater integration.

-There are currently more obstacles and challenges than there are perceived and recognised opportunities, although quite a number of obstacles could be reconceptualised as opportunities.

QUESTION FOUR: What can we learn from the history of advocacy for curriculum integration?

- discipline-specific knowledge is always the fall-back position due to its traditional and entrenched structure
- heavily dependent on curriculum leaders and individual team members
- not all reforms survive (eg STS in late 1980/early 1990s)
- innovation needs to be adequately supported else default is to the traditional
- teachers need to be freed up enough from top-down directives and imperatives to embrace the changes
- the more things change, the more they stay the same
- the politics of reform need to be openly acknowledged and properly addressed
- need to secure funding by reaching consensus on what it stands for

- accountability culture makes change difficult
- need to continually upscale from initial work by pioneers
- teachers need to be given adequate time and flexibility to learn and adapt to the changes
- build in changes from the early years onwards
- real change means making familiar things substantially different
- new agenda requires a new curriculum
- integration can lead to loss of depth, and loss of teacher confidence
- teachers can be cynical about changes perceived as temporary or faddish
- strengthening changes with community engagement (eg model of environmental studies)

Emergent theme/s-

-Change requires a clear vision, adequate support and scaffolding, and ways of identifying and absorbing resistance.

Additional questions raised:

How do we support and sustain integrated models that have proved historically unstable?

Why do we still have separate discipline studies?

Where best to begin STEM integration?

How best to get teachers to let go and embrace the new?

Is it better to establish initial discipline learning separately, then integrate at a higher year level?