Examining the ‘STEM’ conundrum: myth, crisis or something in-between?

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‘STEM’ skills – essential for success?
Overview

- Study aims & methods
- Findings from the literature
- Definitions
- STEM education metrics
- O*Net
- ‘STEM’ focus & skills
Aims of study

Frame a consistent definition of ‘STEM’ knowledge and skills

Identify the place of ‘STEM’ skills in a holistic skills framework

Highlight ‘STEM’ knowledge and skills in VET education and VET workforce
Methodology
Current ‘STEM’ debate
Defining ‘STEM’ skills

• Mix of
  – technical/task skills,
  – ‘soft’ skills
  – higher-order cognitive skills

• Focus
  – Education
  – Workforce (Economy)

• Definitions
  – Interdisciplinary, meta-disciplinary, integrated
  – Discipline or subject specific
Conceptual definition of STEM education

- STEM taught and applied
  - A) traditional and discipline specific
  - B) interdisciplinary and integrated
- Outcome focussed
  - To solve real world challenges
- Investing into human capital
  - Technical and scientific skills
  - Critical and creative thinking skills

- Teachers/Educators,
- Scientists, engineers and digital specialists
- Technologically proficient workers
- Literate citizens
Defining STEM skills & knowledge

• STEM is an acronym / a new term
• Interdisciplinary
• Aim of enhancing people’s competency
  – in work and/or life
  – to protect and improve societal demands on technology
• Technical and task related skills
• Difficult to measure directly
• Approximated by subject or discipline specific skills
Society
Values
Needs
Environment
Economy

Technologies

Scientists
incl. Mathematicians

Engineers

Scientific Knowledge
Example for STEM skills
Defining S.T.E.M. skills & knowledge

• S.T.E.M. is a collective term
• Full discipline names preferred
• Single disciplinary / discipline specific
• Value free
• Technical and task related skills
• Measurable by subject or discipline specific standard classification
Example for S.T.E.M. skills
Data driven definitions

- Field of education/study – ASCED/ISCED
- Level of education/study – ASCED/ISCED
- Occupation - ANZSCO
- Derived and applied ‘STEM’ categories?
Field of Education Classification

01 NATURAL AND PHYSICAL SCIENCES
02 INFORMATION TECHNOLOGY
03 ENGINEERING AND RELATED TECHNOLOGIES
04 ARCHITECTURE AND BUILDING
05 AGRICULTURE, ENVIRONMENTAL AND RELATED STUDIES
06 HEALTH
07 EDUCATION
08 MANAGEMENT AND COMMERCE
09 SOCIETY AND CULTURE
10 CREATIVE ARTS
11 FOOD, HOSPITALITY AND PERSONAL SERVICES
12 MIXED FIELD PROGRAMMES
### ASCED - ‘Field of Education’ detail

#### 03 ENGINEERING AND RELATED TECHNOLOGIES

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#### 06 HEALTH

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Data example 1:

- Number of enrolments in VET qualifications
- VET provider collection, publically funded training
- AQF Certificate III and higher

Case A) ASCED major fields 1-3 -> core ‘STEM’

Case B) ASCED major fields 1-6 -> extended ‘STEM’
A) TP qualifications in ‘core STEM’?

260,000 ‘STEM’ enrolments in 2014?

- 03 - Engineering and related technologies
- 02 - Information technology
- 01 - Natural and physical sciences
B) TP qualifications in ‘extended STEM’?

466,000 ‘STEM’ enrolments in 2014?

- 06 - Health
- 05 - Agriculture, environmental and related studies
- 04 - Architecture and building
- 03 - Engineering and related technologies
- 02 - Information technology
- 01 - Natural and physical sciences
### Data example 2: people with ‘STEM’ qualifications

<table>
<thead>
<tr>
<th>Org</th>
<th>Data source</th>
<th>Field of education</th>
<th>Level of education</th>
<th>Number of people</th>
<th>% of total population (&gt;15 yrs, 2011)</th>
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<td>ABS</td>
<td>ABS Survey of Learning and Work 2010-11</td>
<td>NPS, IT, ETRS, AERS</td>
<td>AQF Cert III and higher</td>
<td>2,718,300</td>
<td>15%</td>
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<tr>
<td>NILS</td>
<td>ABS Census 2011</td>
<td>NPS, IT, ETRS</td>
<td>AQF Bachelor and higher</td>
<td>651,000</td>
<td>4%</td>
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</table>
Identifying STEM occupations

- Field of education qualification
- > 50% in ANZSCO occupation
- Top occupations (100% - 51%)
  - Medical & Nursing*
  - ICT
  - Engineering & Technicians
  - Scientists
  - Education professionals*
O*Net

Worker-oriented

Worker Characteristics
- Abilities
- Occupational Interests
- Work Values
- Work Styles

Worker Requirements
- Skills
- Knowledge
- Education

Experience Requirements
- Experience and Training
- Skills - Entry Requirement
- Licensing

Cross Occupation

Occupational Requirements
- Work Activities:
  - General
  - Intermediate
  - Detailed
- Organizational Context
- Work Context

Workforce Characteristics
- Labor Market Information
- Occupational Outlook

Occupation-Specific Information
- Title
- Description
- Alternate Titles
- Tasks
- Tools and Technology

Occupation Specific

Job-oriented
Holistic skills framework

- Employment/workplace orientated
- 21st century skills
- Combination of different skills
  - COGNITIVE
  - SOCIO – EMOTIONAL
  - TECHNICAL (STEM, S.T.E.M. skills part of!)
A different ‘STEM’ approach

Economy, Politics, Society….

STEM development & design → STEM output → Post production
A different ‘STEM’ approach

STEM output plan → Skills stocktake & education → STEM development & design → STEM output → Post production

Economy, Politics, Society….
A different ‘STEM’ approach

STEM output plan → Skills stocktake & education → STEM development & design → STEM output → Post production

Economy, Politics, Society….

Variety of skills & knowledge
- Technical, Business
- Technical, STEM
- Technical, Non-STEM
- Cognitive
- Socio-emotional
TAFE SA ‘Solar Spirit’
The Flow Beehive
Summary

• Most ‘STEM’ descriptions vague or too broad
• Interdisciplinary STEM skills ≠ S.T.E.M. skills
• Improve descriptions of jobs ↔ O*NET model
• Need holistic skill framework for work & outputs
• VET strong in
  – foundational literacies
  – industry collaboration
  – applied research & technology
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