Professional Learning Communities as a Model of Professional Development in Pre-Service Teacher STEM Education

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Conceptualizations of STEM

- Generally ‘STEM’ can be conceptualized in two ways within teaching and learning:
  1. used to refer collectively to the teaching of the disciplines within its umbrella (science, technology, engineering and mathematics) &
  2. STEM as a cross-disciplinary (integrated) approach to teaching and learning (National STEM School Education Strategy, 2015)
- In this study the teaching and learning focus aligns with 2.

Why the focus on STEM?

- STEM education is well placed to teach skills that are relevant in the information-rich modern economy, such as problem solving and evidence-based thinking (Office of the Chief Scientist, 2012).
- The Health of Australian Science report (2012) warned that enrolments in many Australian STEM university courses are flat or declining
- Unfortunately, research indicates disengagement begins in Primary mathematics and science.
- Inquiry based STEM approaches are seen as offering increased and sustained engagement.

Study Background

- Data for this study was collected as part of an elective subject delivered as a part of the Reconceptualising Mathematics and Science Teacher Education Program (ReMSTEP).
- This subject has been delivered for the last three years.
- This program is designed to foster collaboration between scientists and educators.
- Over the three years PSTs have worked with MGSE staff, scientists (Museum Victoria), the Faculty of Science, Schools, the Gene Technology Access Centre (GTAC) and the Victorian Space Science Education Centre (VSSEC).

Study Background

- Seven ‘innovations’ were developed to conceptually underpin ReMSTEP.
- The elective subject was designed to align with ‘Innovation 3:
  - Science Specialisations within primary pre-service programs’.
- PSTs who successfully complete the program graduate with a primary science education ‘specialisation’.

Study Justification

- Lyn English (Professor of STEM in Education at QUT) recently made the following observation (2015)*:
  - *Although reference to science could be interpreted as encompassing mathematics, I nevertheless argue that there is a real danger that science will overshadow the importance of mathematics in today's world.*
- The following is offered in a cautionary manner:
  - *Indeed, the STEM acronym itself is frequently referred to as simply "science".*

* English, L. (2015). *STEM: Challenges and Opportunities for Mathematics Education*. Paper presented at the 39th Psychology of Mathematics Education Conference, Hobart, Australia.

Study Aims/ Questions

- Within this study, we will predominantly be concerned with how/if the S or the M (within STEM) are privileged/ inhibited within a STEM based approach to the teaching of upper primary students.
- Specifically, we aim to investigate the question:
  - Is mathematics or science privileged when Pre-service Teachers (PSTs) engage in peer learning in a STEM context?

Study Design

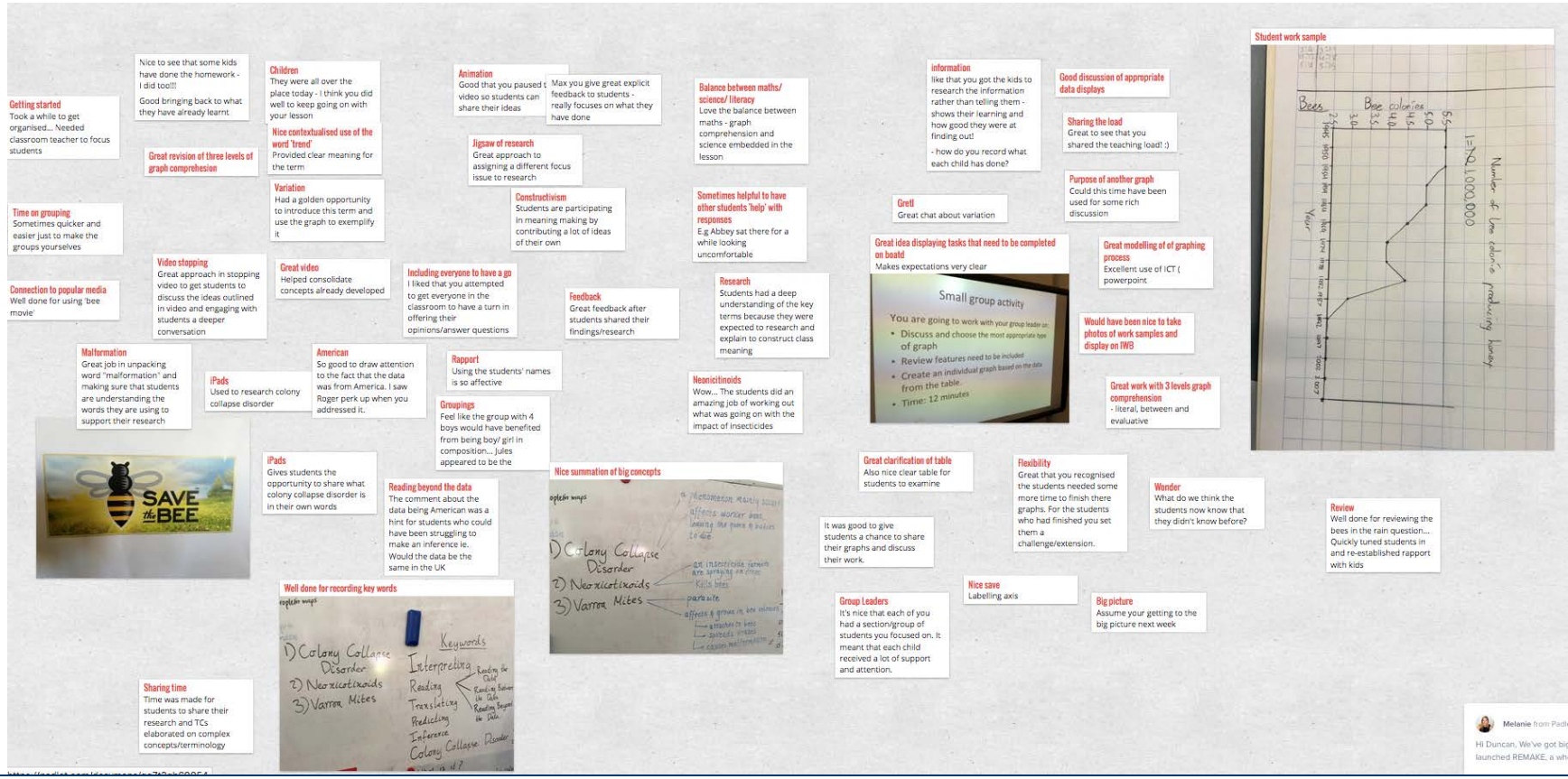
- Students in this subject were supported to develop skills that enabled them to work effectively in Professional Learning Communities (PLCs).
- These skills included collaborative planning and reviewing of their own teaching within a series of 4 STEM based lessons that were implemented into classrooms on a weekly basis.
- PSTs observed and responded to each other's teaching, providing real time feedback using 'Padlet' (a readily available web based application).
- Following each lesson students used the resultant 'Padlet' data as a prompt to promote reflective discussion.

Study Design

- Data derived from ‘Padlet’ was imported into NVIVO (qualitative analysis software) where it was coded in an effort to understand how PSTs focussed their feedback.
- In an effort to understand whether mathematics might be ‘overshadowed’, all comments were coded to align with their main focus. The following codes were utilized:
  - Science
  - Technology
  - Engineering
  - Mathematics
  - STEM/ STEAM
  - General Pedagogy
- Data was then aggregated in effort to understand where/ how PSTs focused their feedback

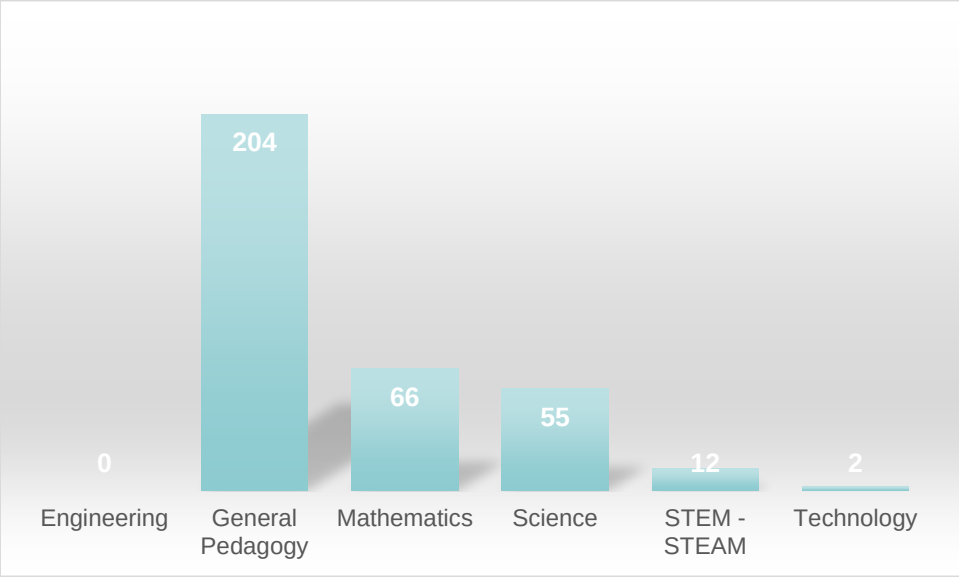
Example ‘Padlet’

- The following is a screen shot taken from ‘Padlet’.
- With your group discuss (and be prepared to share) how the PSTs in this example have focused their feedback
- Does anything surprise you/ interest you? Other thoughts?



Feedback Provided by PSTs Coded by Discipline

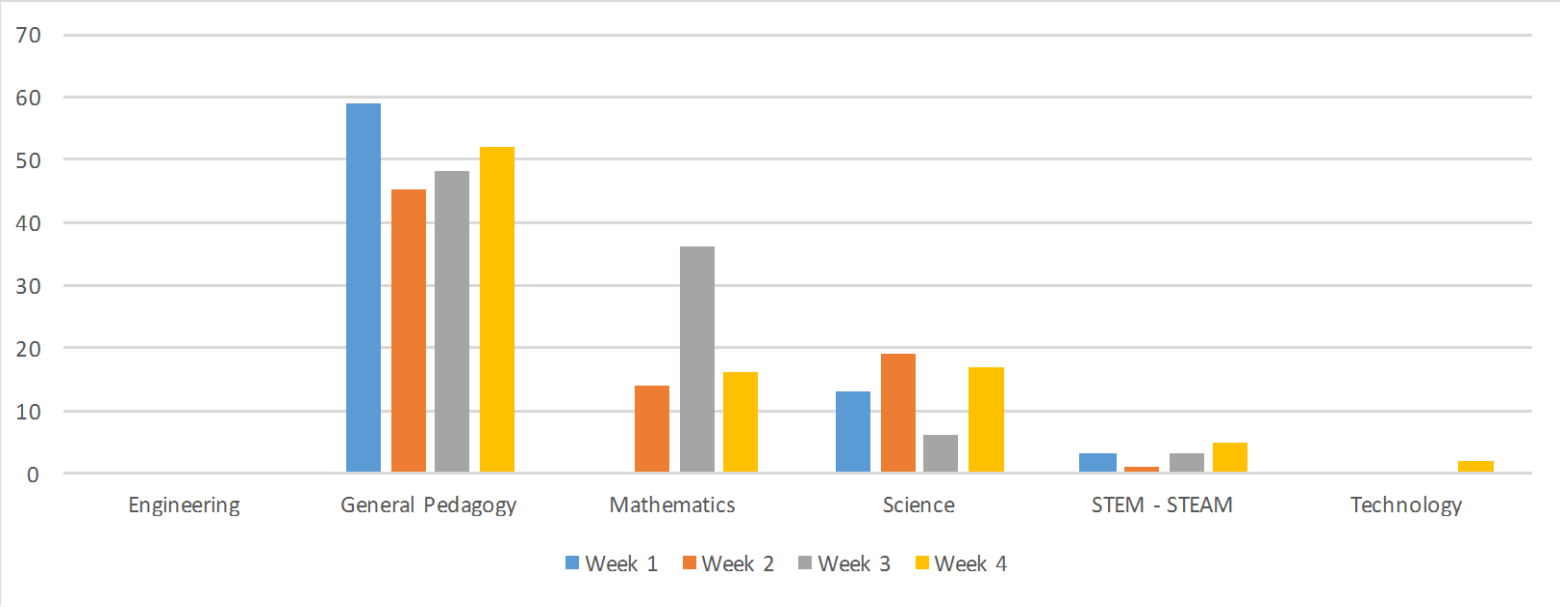
	Group A	Group B	Group C	Total
Engineering	0	0	0	0
General Pedagogy	60	51	93	204
Mathematics	37	21	8	66
Science	19	11	25	55
STEM - STEAM	6	1	5	12
Technology	0	2	0	2



Findings

Comparison of Feedback: Weeks 1 - 4

	Week 1	Week 2	Week 3	Week 4
Engineering	0	0	0	0
General Pedagogy	59	45	48	52
Mathematics	0	14	36	16
Science	13	19	6	17
STEM - STEAM	3	1	3	5
Technology	0	0	0	2



Discussion/ Conclusion/ Implications

- By far the the most common type of feedback provided related to ‘general pedagogy’.
  - This included, for example discussion of the role of ‘questioning’, ‘dialogic teaching’, ‘levels of engagement’ and ‘building relationships/ rapport with students’.
- Feedback relating to ‘mathematics’ occurred slightly more often than ‘science’
- This was unexpected, given the context of the investigation (bees/ adaptations and pollination) was highly scientific in nature.
- This also contrasts with English’s (2015) observation that Science may ‘overshadow’ mathematics when working within a STEM context.

Discussion/ Conclusion/ Implications

- No mathematics centered feedback occurred in the first week of the teaching sequence.
- We hypothesize that the ’scientific context’ was central to ‘setting the scene’ for the investigation.
- In contrast, ‘Science’ related feedback was in greatest evidence in the initial 2 weeks of the sequence.
- An implication may be that when developing a framework to be utilized by PSTs engaged in STEM teaching, Science should be considered the host domain, creating the narrative/ context.
- Mathematics is used to interrogate, analyze and communicate understanding.
- Neither discipline need be overshadowed. Instead PSTs should be encouraged to achieve balance, utilizing science and mathematics in a purposeful, targeted and synergistic manner.

Discussion Questions

- All of the following questions developed through preparation of this presentation.
- Some questions are directly related; others are slightly ‘tangential’.
- Discuss with the people around you and be prepared to share:
  - How can we ensure a ‘balanced’ representation of the individual disciplines when taking an integrated STEM approach? Should we attempt to obtain a balanced representation of the disciplines?
  - There is currently a belief that all teaching and learning should include a clear ‘Learning Intention’.
    - How do we ensure clarity of a (possibly discipline specific) LI when utilizing an integrated STEM based approach?
  - How can/ can STEM based units of learning be structured such that students understand the interrelated nature of the content/ processes they are broadly examining, whilst clearly developing concepts from the individual disciplines in a targeted manner?
    - Can the need to ‘integrate’ cloud/ obscure the learning? How is this best avoided?

Discussion Questions

- Certain skills and processes may be considered common to both mathematics & science (e.g. data collection, analysis, representation and communication, conjecturing/ hypothesizing etc.). However, in traditional disciplinary lessons students often see these processes as belonging to the discipline they are currently considering.
  - What impact may this have on their learning?
- Research (Cosh, 1999), Gosling, 2002, Martin & Double, 1998) suggests that peer observation should be a 'non-judgmental' process; where participants focus their feedback on what **students** 'say and do' rather than on the teacher/ facilitator.
  - Is it possible for this lack of subjectivity to be present or will there always be issues of empowerment/ disempowerment?

Discussion Questions

- Another common suggestion promoted to support non-judgmental feedback is to select a single, particular area of interest or potential problem to focus feedback on (e.g. questioning, pace, or discipline specific feedback) (Cosh, 1999).
  - In reality is this contrived? Does this constrain discussion? Do we lose valuable opportunities to provide feedback outside of the selected area? Will/do participants simply ignore this?
- The PSTs within our STEM elective were aware that they would be required to reflect on the Peer Observation process as part of their formal assessment. They had also studied research describing various approaches (for example ‘Japanese Lesson Study’. This gave the process a degree of legitimacy.
  - Is an equivalent level of legitimacy (or ‘buy-in’) possible for in-service teachers? How can this be achieved?