



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

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- 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.



- 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.

- 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).



- 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’.



- 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.



- 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?



- 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.



- 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?

Getting started
Took a while to get organised... Needed classroom teacher to focus students

Nice to see that some kids have done the homework - I did too!!
Good bringing back to what they have already learnt

Children
They were all over the place today - I think you did well to keep going on with your lesson

Nice contextualised use of the word 'trend'
Provided clear meaning for the term

Variation
Had a golden opportunity to introduce this term and use the graph to exemplify it

Great revision of three levels of graph comprehension

Video stopping
Great approach in stopping video to get students to discuss the ideas outlined in video and engaging with students a deeper conversation

Great video
Helped consolidate concepts already developed

Including everyone to have a go
I liked that you attempted to get everyone in the classroom to have a turn in offering their opinions/answer questions

Feedback
Great feedback after students shared their findings/research

Research
Students had a deep understanding of the key terms because they were expected to research and explain to construct class meaning

Neonictinoids
Wow... The students did an amazing job of working out what was going on with the impact of insecticides

Great idea displaying tasks that need to be completed on board
Makes expectations very clear

Small group activity
You are going to work with your group leader on:
• Discuss and choose the most appropriate type of graph
• Review features that need to be included
• Create an individual graph based on the data from the table
• Time: 12 minutes

Great modelling of graphing process
Excellent use of ICT (powerpoint)

Would have been nice to take photos of work samples and display on IWB

Great work with 3 levels graph comprehension
- literal, between and evaluative

Flexibility
Great that you recognised the students needed some more time to finish these graphs. For the students who had finished you set them a challenge/extension.

Wonder
What do we think the students now know that they didn't know before?

Review
Well done for reviewing the bees in the rain question... Quickly turned students in and re-established rapport with kids

Information
Like that you got the kids to research the information rather than telling them - shows their learning and how good they were at finding out!
- how do you record what each child has done?

Good discussion of appropriate data displays

Sharing the load
Great to see that you shared the teaching load! :)

Purpose of another graph
Could this time have been used for some rich discussion

Great!
Great chat about variation

Balance between maths/science/literacy
Love the balance between maths - graph comprehension and science embedded in the lesson

Sometimes helpful to have other students 'help' with responses
E.g. Abbey sat there for a while looking uncomfortable

Constructivism
Students are participating in meaning making by contributing a lot of ideas of their own

Bigwig of research
Great approach to assigning a different focus issue to research

Max you give great explicit feedback to students - really focuses on what they have done

Malformation
Great job in unpacking word "malformation" and making sure that students are understanding the words they are using to support their research

American
So good to draw attention to the fact that the data was from America. I saw Roger perk up when you addressed it.

Report
Using the students' names is so effective

Groups
Feel like the group with 4 boys would have benefited from being boy/girl in composition... Jules appeared to be the

Nice summation of big concepts

IPads
Used to research colony collapse disorder

IPads
Gives students the opportunity to share what colony collapse disorder is in their own words

Reading beyond the data
The comment about the data being American was a hint for students who could have been struggling to make an inference i.e. Would the data be the same in the UK

Well done for recording key words

Starting time
Time was made for students to share their research and TCs elaborated on complex concepts/terminology

Keywords
Interpretive Reading
Transferring
Predicting
Inference
Colony Collapse Disorder

Group Leaders
It's nice that each of you had a section/group of students you focused on. It meant that each child received a lot of support and attention.

Nice save
Labelling axis

Big picture
Assume your getting to the big picture next week

It was good to give students a chance to share their graphs and discuss their work.

Great clarification of table
Also nice clear table for students to examine

Student work sample
A line graph showing the number of bees in a colony over time. The x-axis is labeled 'Year' and the y-axis is labeled 'Number of bees (in millions)'. The data points are: 2006: 2.5, 2007: 3.0, 2008: 3.5, 2009: 4.0, 2010: 4.5, 2011: 5.0, 2012: 5.5, 2013: 6.0, 2014: 6.5, 2015: 7.0, 2016: 7.5, 2017: 8.0, 2018: 8.5, 2019: 9.0, 2020: 9.5, 2021: 10.0. A handwritten note says 'Number of bees (in millions)'. The title is 'Bees'.

Small group activity
You are going to work with your group leader on:
• Discuss and choose the most appropriate type of graph
• Review features that need to be included
• Create an individual graph based on the data from the table
• Time: 12 minutes

Keywords
1) Colony Collapse Disorder
2) Neonicotinoids
3) Varroa Mites

Interpretive Reading
Transferring
Predicting
Inference
Colony Collapse Disorder

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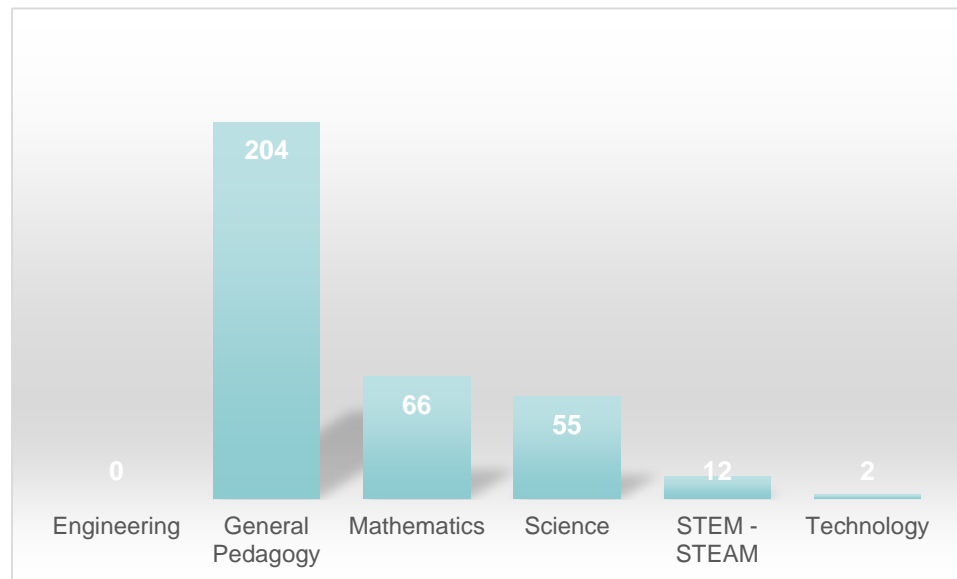
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Feedback Provided by PSTs Coded by Discipline

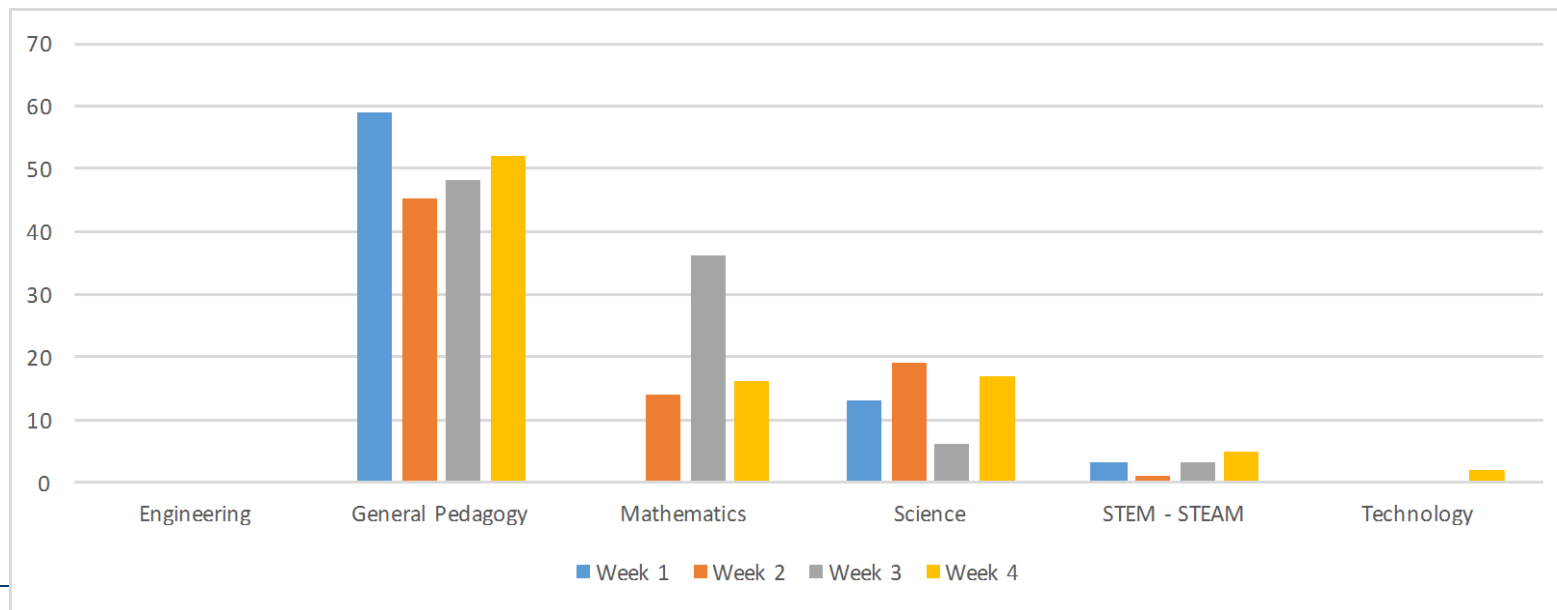
	Group A	Group B	Group C	Total
Engineering	0	0	0	0
General Pedagogy	60	51	93	204
Mathematics	37	21	8	66
Science	19	11	25	55
STEM - STEAM	6	1	5	12
Technology	0	2	0	2





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



- 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.

- 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.

- 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?



- 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?



- 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?