Building the confidence and competence of pre-service primary teachers to teach STEM using an authentic, team-based, integrated project incorporating professional experience

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Background

Teaching & Learning Science in Primary School

• It is known that primary pre-service teachers have minimal teaching experiences in Science while on professional experience

• Many primary pre-service teachers have little formal knowledge of STEM, having avoided the post-compulsory secondary subjects in these fields

• These issues lead to graduating teachers who lack the confidence and competence to teach STEM in schools. However, an understanding of STEM is necessary to create a scientifically literate society
1. Angus, Olney & Ainley, 2007:
“Science is not given importance in Australian primary schools, only 18% of teachers have expertise in teaching science; out of 1486 minutes per week of teaching only 45 minutes is spent on science”

2. Goodrum, Hackling & Rennie, 2000:
64% of Australian primary students indicate (often or always) that in science lessons they have to remember facts

3. TIMSS & PIRLS, 2011:
“Australia’s ... score [in science] ... was significantly higher than that of 23 countries, but below that of 18 countries, including most of the Asian countries, England and the United States” and “Australia’s average Year 4 science score in TIMSS 2011 was significantly lower than ... in TIMSS 2007”
What is MSTIE?

• It was recognized that assessment needed to aim at promoting higher-level thinking and developing greater independent learning

• To achieve this we modified our assessment by developing the MSTIE (Multi-disciplinary Science & Technology Integrated Experience) Project

• These changes also recognize that science does not occur in isolation; it is best learnt when integrated with other subject areas and in the context of the classroom
The MSTIE Program

- MSTIE is a unique problem-based learning and team-teaching program for Bachelor of Education (Primary) pre-service teachers

- The PBL brief to our students is: To address the need for more graduates from STEM courses we need to engage primary school students in STEM. In teams of two you are to cooperatively design, plan, teach and evaluate an engaging, integrated STEM unit as a part of your placement...

- The teams of pre-service teachers collaboratively plan, teach, and evaluate an integrated STEM unit of work in a primary school as a part of their two core subjects (Integrated Science Learning, and Design and Technology), and their three-week practicum

- Simultaneously, the pre-service teachers study and experience how Science and D&T can be integrated into school settings to provide real-world challenges and creative problem-solving with STEM - what the pre-service teachers learn in their core subjects is immediately applied in practice via their MSTIE unit
MSTIE Assessment

- MSTIE is PBL and designed as **authentic assessment**
- The MSTIE project is a major piece of assessment in the two second semester core subjects:
  - 70% of the assessment in Integrated Science Learning, and
  - 40% of the assessment in Design and Technology

- **There are four essential assessment elements:**
  - Team **planning and preparation** of an integrated STEM unit;
  - **Assessment and reflection** on children’s learning, the unit and their teaching;
  - Effective classroom (team-)**teaching** and professional conduct; and
  - A Post-practicum forum **presentation**
MSTIE Assessment (cont.)

• This assessment enhances pre-service teachers’ independent learning and through a real world context provides multiple levels of on-going feedback

• This feedback includes:
  • the teacher mentor and university staff feedback during the writing of the unit and on practicum
  • participating primary student feedback during the practicum
  • feedback from peers during forum presentations and
  • feedback from the assessment of the MSTIE project documentation
The MSTIE Model

- The collaboration between Science education and Design and Technology education has provided opportunities to link integrated teaching/learning in the core subjects with the practicum experience.

- PBL in MSTIE provides a validating and authentic teaching/learning experience for pre-service teachers, university lecturers, teacher mentors and primary school students involved in the program.

- Pre-service teachers, in their team of two, critically reflect on, and assess the success of their MSTIE teaching in school settings, and present these findings to their peers in a forum presentation.

- Through forum presentations the cohort discover what works, why it works, and what needs rethinking.

- The primary school students provide authentic feedback through the completion and record keeping/journaling of their own learning experiences, that demonstrate the connections between university led theory-to-practice teaching, and real-world practical outcomes.
Key Elements of the MSTIE model

- The use of the 5E instructional model as a framework for planning and teaching
- Pre-practicum visits (six half-days) to understand the school context in which they are planning and teaching their STEM unit
- Scaffolding the Unit planning process with appropriate documentation
- Planning, teaching, and reflecting in teams of two
- Linking the planning to the curriculum
- Integrating Science with Design and Technology and other parts of the curriculum

- ***SHOW MSTIE VIDEO – ELEMENTS OF FORUM PRESENTATION***
Back-story
Four-year study of Pre-service Teachers’ Ratings of their increased Confidence and Competence to Teach Science
(1=SD, 2=D, 3=NS, 4=A, 5=SA)
Back-story
Four-year study of Pre-service Teachers’ Ratings of the value of team teaching
(1=SD, 2=D, 3=NS, 4=A, 5=SA)
Back-story

Qualitative analysis of responses:

The pre-service teachers reported increase in confidence and competence to teach science following the teaching of their MSTIE unit can be attributed to:

• The proactive nature of the pre-planning process
• The provision of scaffolding and modelling in the university subjects that link directly to the MSTIE process
• Effective team-teaching supporting an innovative and authentic classroom environment.

The pre-service teachers value team teaching in MSTIE, this can be attributed to:

• The development of a professional relationship and shared goals
• The opportunity to work as a team in a professional experience where they can learn from each other.
Current MSTIE Research and Findings

• This study examined the influence of the MSTIE program on third year primary pre-service teachers’ confidence, competence, skills and teamwork in teaching science at primary school (n = 139) over two consecutive years.

• A case study of pre-service teachers participating in the MSTIE program is used to investigate the research questions. The case study is composed of a survey involving 139 pre-service teachers who participated in the MSTIE project, 67 in 2012 and 72 in 2013.

• Major Research Questions:
  • How does the MSTIE program contribute to pre-service teacher’s confidence and competence to teach science in primary schools?
  • How do pre-service teachers rate the relative effectiveness of the various components of the MSTIE program?

• The survey involved a mixture of qualitative and quantitative questions to explore the research questions with both likert scale and open-ended responses. These data were analysed using quantitative and qualitative methodologies.
### Pre-service Teachers’ average Likert responses to the General Components of MSTIE (1=SD, 2=D, 3=N, 4=A, 5=SA)

<table>
<thead>
<tr>
<th>Rank</th>
<th>General Components of MSTIE</th>
<th>Av. Score</th>
<th>% SA &amp; A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Pre-practicum visits gave me a good understanding of the school context</td>
<td>4.63</td>
<td>96.40</td>
</tr>
<tr>
<td>2</td>
<td>Pre-practicum visits improved my confidence in planning &amp; teaching science</td>
<td>4.63</td>
<td>94.24</td>
</tr>
<tr>
<td>3</td>
<td>Working as a team improved my competence to teach science</td>
<td>4.42</td>
<td>88.49</td>
</tr>
<tr>
<td>4</td>
<td>The 5E model was an effective framework to think about teaching and learning</td>
<td>4.40</td>
<td>94.24</td>
</tr>
<tr>
<td>5</td>
<td>The 5E model was effective to identify student conceptual growth</td>
<td>4.40</td>
<td>93.53</td>
</tr>
<tr>
<td>6</td>
<td>Integrating with other disciplines provided authentic situations to learn science</td>
<td>4.36</td>
<td>93.53</td>
</tr>
<tr>
<td>7</td>
<td>Integrating with other disciplines made my science teaching more effective</td>
<td>4.35</td>
<td>93.53</td>
</tr>
<tr>
<td>8</td>
<td>The 5E model was an effective planning tool</td>
<td>4.34</td>
<td>91.37</td>
</tr>
<tr>
<td>9</td>
<td>Working as a team improved my confidence to teach science</td>
<td>4.34</td>
<td>86.33</td>
</tr>
<tr>
<td>10</td>
<td>The scaffolding documentation provided clarity about the MSTIE program</td>
<td>4.32</td>
<td>96.40</td>
</tr>
</tbody>
</table>
Quotes:

Q1.13
“I enjoyed MSTIE. I especially liked visiting the school prior to starting and being organised early. The fact that we got to integrate numerous domains / dimensions was fun and a great experience”

Q2.13
“Amazing experience! Lots of hard work and stressful times but well worth it for the experience and results.

Whatever we had heard about MSTIE beforehand didn’t do it justice! MSTIE is great for many reason: teamwork, experience, inquiry documentation ... etc.”
### Pre-service Teachers’ average Likert responses regarding Personal Outcomes from MSTIE (1=SD, 2=D, 3=N, 4=A, 5=SA)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Personal Outcomes from MSTIE: Following MSTIE I ...</th>
<th>Av. Score</th>
<th>% SA &amp; A</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Can now provide rich learning in science with hands-on activities</td>
<td>4.61</td>
<td>98.56</td>
</tr>
<tr>
<td>2</td>
<td>Have improved my ability to work in a team</td>
<td>4.54</td>
<td>94.96</td>
</tr>
<tr>
<td>3</td>
<td>Have a high level of ownership over my MSTIE unit</td>
<td>4.53</td>
<td>94.20</td>
</tr>
<tr>
<td>4</td>
<td>Have improved my confidence in teaching science</td>
<td>4.52</td>
<td>94.96</td>
</tr>
<tr>
<td>5</td>
<td>Have improved my competence in teaching science</td>
<td>4.52</td>
<td>95.68</td>
</tr>
<tr>
<td>6</td>
<td>Can now plan an integrated science unit based on any curriculum</td>
<td>4.51</td>
<td>97.12</td>
</tr>
<tr>
<td>7</td>
<td>Can plan science lessons based on the learner’s needs</td>
<td>4.44</td>
<td>95.68</td>
</tr>
<tr>
<td>8</td>
<td>Can now use an inquiry based framework for teaching science (5E model)</td>
<td>4.43</td>
<td>96.40</td>
</tr>
<tr>
<td>9</td>
<td>Can connect science to the daily life and context of students</td>
<td>4.40</td>
<td>96.40</td>
</tr>
<tr>
<td>10</td>
<td>Can plan science lessons based on school resources and curriculum needs</td>
<td>4.40</td>
<td>94.96</td>
</tr>
</tbody>
</table>
Quotes:

2012 Quotes

Q1. 12

“Loved MSTIE!. Taught me so much about planning units, assessment, working as a team and boosting my confidence in teaching and planning so much loved it all!”

Q3.13

“Opportunity to teach and work together was fantastic. Saw the value of 5E when we implemented”
### Pre-service Teachers’ Ratings of the Contribution of each Aspect of the MSTIE Program to their Confidence and Competence to Teach Science (1=VL, 2=L, 3=M, 4=H, 5=VH)

<table>
<thead>
<tr>
<th>Aspects of the MSTIE program</th>
<th>Contribution to Confidence (Av. Score)</th>
<th>% SA &amp; A</th>
<th>Contribution to Competence (Av. Score)</th>
<th>% SA &amp; A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-practicum visits</td>
<td>4.54</td>
<td>92.81</td>
<td>4.49</td>
<td>92.81</td>
</tr>
<tr>
<td>Teamwork</td>
<td>4.47</td>
<td>91.37</td>
<td>4.46</td>
<td>91.37</td>
</tr>
<tr>
<td>Documentation</td>
<td>4.31</td>
<td>92.09</td>
<td>4.37</td>
<td>92.09</td>
</tr>
<tr>
<td>Integration</td>
<td>4.27</td>
<td>90.65</td>
<td>4.40</td>
<td>94.96</td>
</tr>
<tr>
<td>5E Model</td>
<td>4.20</td>
<td>89.21</td>
<td>4.29</td>
<td>89.93</td>
</tr>
<tr>
<td>Linking to curriculum</td>
<td>4.17</td>
<td>86.33</td>
<td>4.26</td>
<td>90.65</td>
</tr>
</tbody>
</table>
Quotes:

Q2.12

“Fantastic experience. Related highly to my future teaching and having the documentation when applying for jobs”

Q3.12

“I loved this program. It is really set me up for success in my future teaching in science and beyond”

Q4.12

*MSTIE was excellent it provided great experience in planning and implementing a science unit. We now have a solid unit of work in which we can use as evidence of our planning*”
Conclusions:

These data indicated that the pre-service teachers reported an increase in confidence and competence to teach science following the teaching of their MSTIE unit, and this could be attributed to:

• the proactive nature of the pre-planning process;

• the provision of scaffolding and modelling in the university subjects that link to MSTIE; and

• effective team-teaching supporting an authentic classroom environment.
References


TIMSS 7 PIRLS. (2011). Highlights from TIMSS & PIRLS 2011 from Australia’s perspective. ACER
Thank you