

The La Trobe Discovery STEM Initiative Evaluation Report

Discovery Science and Technology Centre Bendigo

La Trobe University

Reconceptualising Mathematics Science Teacher Education Programs

Office of Learning and Teaching

Lighting Reef Primary School

Camp Hill Primary School

Quarry Hill Primary School

Eaglehawk Primary School

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La Trobe University



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• Executive summary

This report provides analysis of the La Trobe Discovery STEM Initiative (LTDSI) conducted between the 4th of May and the 27th of May, 2016. The LTDSI was conducted at the Discovery Science and Technology Centre (DSTC) for primary school Pre-Service Teachers (PSTs) in their second year of study at La Trobe University (LTU), Bendigo. The program involved four local primary schools, Lighting Reef Primary School, Camp Hill Primary School, Quarry Hill Primary School, and Eaglehawk Primary School who were incorporating the Primary Connections units into their classrooms.

The LTDSI program was funded by Reconceptualising Mathematics Science Teacher Education Programs (ReMSTEP), a collaboration between University of Melbourne, Monash University, Deakin University, and La Trobe University. ReMSTEP is funded by the Office for Learning and Teaching. The expressed aims of this program for ReMSTEP were specialist science and technology centre collaborations (Innovation 4) and Building a recruitment pipeline of high potential mathematics and science teachers (Innovation 7)¹.

For the duration of the program PSTs were required to prepare and team teach primary school classes using the 5E model of teaching. The classes were based upon a Primary Connections units being taught to the class, and focussed on the engage phase of the model. The PSTs were to accompany the class to DSTC on an excursion to utilise the facilities at DSTC and help facilitate small group work in one of the workshops provided at DSTC under the guidance of a DSTC facilitator. The PSTs were to also produce an explore phase lesson plan based upon the activities conducted as DSTC and an elaborate phase lesson plan incorporating technology.

The evaluation of the outcomes for the PSTs and mentor teachers from the primary schools was conducted using a variety of methods; small group interviews using a predetermined set of semi – structured questions, post activity surveys of the PSTs and mentor teachers, analysis of the reflective reports generated as a part of the assessment for EDU2TS, and observations of an onsite evaluator for 3 of the 4 weeks the program was run at DSTC.

In relation to the PSTs the program was found to be successful. 50% of PSTs strongly agreed to the statement “There has been a positive change in my attitude towards science and/or teaching science”, and 38% somewhat agreeing.

The outcomes for mentor teachers were not as positive where many were disappointed with the execution of the program and the organization. Although many mentor teachers reflected that the workshops conducted by DSTC were good they found them too brief in some instances.

Key recommendations from the evaluation of the LTDSI are;

- Organisation of the LTDSI needs to be improved by information being provided by LTU to PSTs and mentor teachers from the beginning of the program detailing; when activities were going to take place, who was expected to take the engage phase lessons, what was to occur during DSTC visits, and what the assessment criteria was. Also detailing the expectations of the PSTs with regards to teaching engage phase lessons and helping small group work at DSTC during the workshops.
- All the information for the PSTs to complete this assessment task needed to be provided in a more coherent format than what was done during the pilot program, with much more lead time than was provided. This could take the format of a dedicated section on the LMS page for the LTDSI program, with all primary connections units, run sheets from DSTC, timings of activities and classes, as well as well as expectations of the PSTs and assessment criteria of their work. This would ideally be provided to PSTs at least 1 week prior to the DSTC induction session.
- For the workshops that are being conducted at DSTC, they should be more explicitly standardised with regards to the learning outcomes being provided to students. This standardisation may include; vocabulary, content, and activities. Also use of the Primary Connections units to develop a workshop for each Primary Connections unit, and tailor each workshop to a variety of classes. I.e. sounds like for Prep, Grade 1 and Grade 2 as well as

composite classes to ensure that outcomes are met for each level of the Australian Curriculum.

- As there is an engage phase class that is occurring before the DSTC visit, work with the PSTs to make sure that DSTC is aware of prior knowledge and ability of the students and that the level of the workshop is tailored to the needs and knowledge of the students.
- Due to the large variation of the workshop length and issues with students missing out on activities such as the vertical slide, only have one or two classes per session. This will ensure that each class gets adequate time to engage with all activities and the workshop without spending too much time waiting for the workshop.
- There was pressure to get all school classes in during the allotted time, therefore if there was to be a similar or larger number of students the LTDSI should be run over a longer time to allow for more flexibility of class timetables and school schedules.
- Clear and concise communication of needs and requirements of students by the mentor teacher for the specific classes that need to be taught by the PSTs and DSTC.

Limitations of the findings from this evaluation are; the moderately low response rate from the surveys conducted with 17% of PSTs responding and 29% of mentor teacher responding, and the interviews that were conducted were not conducted with all PSTs and mentor teachers due to time constraints.

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• Introduction

Overview of Project and Goals

The 2016 La Trobe Discovery STEM Initiative (LTDSI) was a pilot program, conducted on the 5th though to the 27th of May 2016 at the Discovery Science and Technology Centre (DSTC) for primary school Pre-Service Teachers (PSTs) in their second year of study at La Trobe University (LTU), Bendigo. The program also involved four local primary schools, Lighting Reef Primary School, Camp Hill Primary School, Quarry Hill Primary School, and Eaglehawk Primary School who were incorporating the Primary Connections units into their classrooms.

The activities that the PSTs conducted as a part of the LTDSI were;

- An introductory session at DSTC
- Interactions and planning of the LTDSI with a “mentor” in-service teacher at a local primary school
- Planning and team teaching of an engage lesson to a class of primary students in a class room in conjunction with the mentor teacher
- Assisting and participating in the workshop for the same primary school class at DSTC
- Completion of a journal for their formal assessment of the program

The program was funded by Reconceptualising Mathematics Science Teacher Education Programs (ReMSTEP), a collaboration between University of Melbourne, Monash University, Deakin University, and La Trobe University. The expressed aims of this program for ReMSTEP were, specialist science and technology centre collaborations (Innovation 4) and Building a recruitment pipeline of high potential mathematics and science teachers (Innovation 7)¹.

The LTDSI was incorporated into a core course of the bachelor of education (Course code: EVEDB) titled “*Teaching Science*’ (Subject code: EDU2TS) as assessment task 2. For the EDU2TS, the program has several outcomes as stated in the subject learning guide², which are as follows.

Subject intended learning outcomes (SILOs) for the task were;

1. Demonstrate an ability to find and incorporate appropriate curriculum knowledge associated with teaching science in schools through effective planning for teaching – including the ability to access relevant science curriculum documents and apply them in planning for learning, and to select appropriate resources.
2. Design and construct learning environments that are meaningful and engaging for learners and which meet their learning needs.
3. Develop method specific assessment tasks of teaching and learning for a variety of formative and summative purposes.

The graduate capabilities (GC) that the students are evaluated for their assessments were;

1. Literacies and Communication Skills
2. Inquiry and Analytical Skills
3. Personal and Professional Skills
4. Discipline Specific Knowledge and Skills

The Australian Professional Standards for Teachers (APSTs) that were aimed to be developed during the course of the program were;

1. Know students and how they learn
2. Know the content and how to teach it
3. Plan for and implement effective teaching and learning
4. Create and maintain supportive and safe learning environments
5. Assess, provide feedback and report on student learning

The program also linked to the Primary Connections Units³ for the implementation of the Australian Curriculum⁴ at the F-6 levels. Through the learning activities of EDU2TS the PSTs learnt the pedagogies surrounding the teaching of science, in particular the *5Es* model of teaching.

The purpose of this document is to report upon the evaluation that was conducted throughout the program to determine the effectiveness of the program and to determine the impact of LTDSI for DSTC, LTU, ReMSTEP and the Primary School teachers and students.

Pre-Service Teacher Activities

The activities that the PSTs conducted during the course of the program as listed above were to be conducted as detailed below.

The introductory session at DSTC, involved time for the PSTs to familiarise themselves with DSTC and their staff. They were given time to explore the centre's activities on the main exhibition floor and they were given an introduction session in "The Lab" by DSTC staff on the activities that were going to occur at DSTC when they returned with their primary school class.

For the duration of the program the PSTs were required to communicate with their mentor teacher who was located at one of the four participating primary schools in the local area. As the PSTs were conducting the program in groups of three or four, one of the members of each group was the designated communicator for their interactions with the mentor teacher. These interactions were for planning what was going to be done for the engage lesson and to ensure that any planning activities prior to the engage lesson and the visit to DSTC were completed.

Along with the planning that was conducted with the mentor teacher prior to the visits, the PSTs were required to plan and teach the engage lesson of their topic according to the current class topic of study. The planning of the lesson was to consist mostly of; the PSTs studying the curriculum relating to Primary Connections and to plan a lesson, and then to get feedback from the mentor teacher on the suitability of the lesson and its implementation for their particular class. The delivery of the engage lesson to the class was to be conducted by either the PSTs (in a team teaching environment) or the mentor teacher depending on whether the mentor teacher was confident enough to allow the PSTs full control of the class.

The subsequent workshop relating to the explore phase of the 5Es conducted at DSTC was facilitated by a DSTC staff member. The PSTs were required to assist in the workshop sitting on different tables, where most workshops had the primary school students separated into small groups on different tables. Either before or after the workshop the PSTs were left to their own devices on the floor to interact with the students and exhibits.

The formal assessment of the PSTs for the program consists of a group report (Appendix A- Part A) and individual reflection (Appendix A – Part B) of their views on the program and their views on teaching science.

The evaluation of the Pre-Service Teacher activities seeks to determine the effectiveness of the implementation of the LTDSI and all associated tasks. Also to determine change in PSTs identity with science and their approaches to teaching science.

Discovery Science and Technology Centre Workshops

The activities that were run at DSTC were composed of; time for the primary school's students to explore the exhibition floor, and a workshop based upon the explore phase of the 5Es model and Primary Connections. The primary school students arrived in groups of two to three classes for ease of transportation. As a result of the transportation of a few classes per session the workshops were run one class at a time with the remaining classes remaining on the exhibition floor.

The workshops that were run at DSTC were 30 to 45 minutes in length and were based around the Primary Connections units of Look Listen (Grade 1), Push and Pull (Grade 2), Melting Moments (Grade 3), Smooth Moves (Grade 4), and Change Detectives (Grade 6). The workshop run sheets for the explore phase workshop as implemented by DSTC are shown in Appendix B.

The majority of the DSTC workshops what were conducted for the LTDSI were adaptations of workshops already in place at DSTC. As such the evaluation of the workshops sought to assess the

effectiveness of the workshops for the school teachers as well as the primary school students for delivering the explore phase of the 5Es model of instruction.

- Program rationale and logic

The practice of teaching science in the primary school setting by general (non-specialist) primary teachers has been reported to be a high anxiety subject⁵, with only 50% of primary teachers in 2014 having specialist training in teaching science⁶.

The course that the PSTs were taking as a part of their undergraduate degree *Teaching Science* was designed to directly address this issue. The LTDSI was piloted as a direct means of engaging the PSTs with contemporary practice of teaching science and the associated pedagogies at the primary school level.

Incorporating LTDSI into the DSTC was done in order to use their expertise in linking students with science and to be able to demonstrate these practices to the PSTs through the DSTC workshops.

Through the course of this program there was also hope for stronger connections to be formed between the primary schools, LTU and DSTC.

The engagement of the project was between LTU as the directing body to organise and co-ordinate with DSTC and the local primary schools, and to direct the PSTs as appropriate.

•Evaluation Framework

Purpose of Evaluation

The purpose of the evaluation of the LTDSI is to inform the stakeholders and various other members of the community of the effectiveness of the LTDSI as well as the impact of the DSTC more broadly outside of the LTDSI.

Due to the number of stakeholders in the LTDSI, the evaluation has been developed to encompass as many points of view as possible. The key opinions that have been evaluated through this program are that of the PSTs and the mentor teachers.

The primary goals of DSTC through the evaluation of LTDSI is to evaluate the effectiveness of and seeks to improve the workshops that are delivered to primary schools.

LTU has sought to determine the effectiveness of the LTDSI program for improving the science pedagogies of their PSTs within the bachelor of education (Course code: EVEDB) and in particular the subject titled “*Teaching Science*’ (Subject code: EDU2TS).

Through the course LTDSI, ReMSTEP seeks to improve the competence and confidence of PSTs in teaching science at the primary school level. The evaluation of the LTDSI forms a component of the ReMSTEP goals and as a result needs to be evaluated to determine the effectiveness, such that other funding bodies will continue to fund projects sponsored by ReMSTEP after the expiration of the ReMSTEP grant.

Key Evaluation Questions

Semi-structured interview questions

Does the Discovery Centre Primary Connections activities accurately reflect the relevant Primary Connections units?

- How did the activity conducted at discovery centre enhance the curriculum that you are teaching?

- Does the activity connect with the curriculum?
- Are the activities being conducted at discovery centre relevant to the Australian curriculum?
To the Primary Connections units?

How well does the Discovery Centre activities present the explore phase of the five E's

- In your practice does the Discovery Centre activities fit in with your practice of the five E's
- Does the Discovery Centre activities only focus on the Explore phase of the five E's?
- Should the activity only focus on explore or should the activity do engage, and explain as well?
- What would you change about the activity at Discovery Centre?

Does the activity at the Discovery Centre enhance the learning of the students after the activity in the classroom?

- What was the knowledge level of students after the activity at the Discovery Centre compared with before the activity?
- Did the students use the experience at the Discovery Centre to enhance their learning?
- Did the students engage with the unit of study more after the activity?
- In your experience did the Discovery Centre enhance the learning of the students?

What have the PSTs learnt from the Discovery Centre initiative? How does this inform their practice?

- What did you learn from the activities conducted at the Discovery Centre?
- Does the activity you have done at the Discovery Centre reflect the content of your course at university? Why yes, why not?
- Do you think that the activity at the Discovery Centre is beneficial to your practice?
- What is different about the method of teaching at the Discovery Centre from your experience?
- Would you incorporate any of the methods at the Discovery Centre into your practice?

What effect on students' learning does the Discovery Centre have?

- Does the activity at the Discovery Centre help your practice?
- Do the students engage more with the content?
- Is there a difference in how you taught the unit of work at the school before and after the discovery experience?
- What impact did the activity at the Discovery Centre have on the classroom?

What planning and/or orientation activities were done with your students before the visit to the Centre? How did you collaborate with your mentor teacher?

What were your expectations of what would happen at the Centre including your role there?

What were your perceptions of your students' engagement and learning when they were at the Centre? What did you personally learn at the Centre? Was your role as you expected?

What do you perceive to be students' learning gains from the Centre visit? Would you recommend more visits to the Centre? (why/why not?)

What did you know about the Discovery Centre prior to the visit?

What have you learnt about science teaching and learning from participating in planning and conducting this visit?

What have you learnt from collaborating with your mentor teacher in organising and conducting this visit?

To what extent has this experience influenced your views about being an effective teacher of primary science in the future?

Post activity survey questions for PSTs and Teachers

As a result of the REMSTEP activity:

Knowledge change:

1. I gained new insights into scientists' research and development practices and roles.
2. My perceptions of scientists as people changed in a positive way.
3. I learnt some useful and interesting science concepts.

Attitude change:

4. There has been a positive change in my attitude towards science and/or teaching science.

Practice change:

5. I was engaged in new and interesting approaches to teaching science
6. I have learnt things about engaging with contemporary science that will influence my teaching in the future
7. I gained ideas for how to bring contemporary science practices into the school curriculum

Changes in students' engagement, attitudes:

As a result of my students' involvement in the REMSTEP activity:

8. Students developed new understandings of the nature of scientific practices
9. Students were productively engaged with learning science
10. These activities featuring contemporary scientific practices positively impact on students' engagement with science.
11. Overall, I felt the REMSTEP activity worked well.

Ideas for improvement

12. What were the challenges for you in these activities?
13. What aspects of the activity were particularly helpful?
14. What do you feel you gained from the activity?

15. What changes would you suggest to improve the activity?

16. What support would be needed for teachers to use these resources?

Evaluation Team

The evaluation was designed by the ReMSTEP projects and was approved by the DSTC staff and LTU EDU2TS subject co-ordinators.

The semi-structured interview questions were administered by Nick Tran to small groups of PSTs.

The post activity survey questions were administered by Tim Johns using Survey Monkey.

The summary of findings in this document was produced by Nick Tran and Anthony Carter.

Evaluation method

The primary method of evaluation was carried out by sets of interviews conducted by Nick Tran with the PSTs and the mentor teacher using the semi structured questions detailed above. Not all of the questions were relevant to the mentor teacher as some questions were specifically directed to the PSTs and not the mentor teacher.

Secondary methods of data acquisition were; audio visually recording the workshop sessions of the primary school classes at DTSC, collection and analysis of the reports produced by the PSTs, and post activity surveys of the PSTs and mentor teachers.

The interviews were conducted in a group setting comprising of only the PSTs that were involved in workshop under examination, or the interview was conducted informally with the mentor teacher.

The interviewer started all interviews with the PSTs. All notes and data taken from the interview was anonymous and would not be released to the subject co-ordinators until after their results were released. This was done in order to elicit honest responses without fear of repercussions from their answers.

Audio visual recordings were made of the DSTC workshops to capture the interactions of the PSTs, primary school students, mentor teacher, and the DSTC facilitator. This method was used preferentially over direct observations by the evaluators in an effort to minimise the effects of having an outsider in the room which may have influenced the PSTs behaviour. However some workshops were directly observed where audio visual recordings weren't taken due to equipment issues, and to gain first hand non static observations of the workshops.

Collection and analysis of the reports produced by the PSTs as a part of the course work for EDU2TS, was analysed for themes relating to their experience and reflections of the program. While this information is formally reported to the co-ordinators of the EDU2TS and no major negative feedback was expected, the change in the PSTs identity with science and the change in their approaches to teaching science is under examination.

The post activity survey was designed in an attempt to gather data regarding the PSTs and mentor teacher interactions with and opinion of the LTDSI. The surveys used a mixture of Likert style and open ended questions to gather quantitative and qualitative data respectively. Questions 1 – 11 as stated in *Post activity survey questions for PSTs* were Likert style with 6 options (Strongly Agree, Somewhat Agree, Neither Agree not Disagree, Somewhat Disagree, Strongly Disagree, and N/A) with the option to leave a comment if the PST or teacher so desired. Questions 12- 16 were compulsory, open ended questions aimed at obtaining qualitative data on the PSTs and teachers' opinions on the LTDSI.

• Evaluation Findings

The evaluation findings are broken into 4 sections focusing on each of the methods of evaluation; interviews, part B of the formal report from the PSTs, responses through Survey Monkey and, observations made by the evaluator.

Summary of findings from Interviews

Notes from each of the questions and associated sub-questions from the interviews have been collected and analysed to isolate common themes and key points from PSTs or the associated mentor teacher's responses.

Question 1

Does the Discovery Centre Primary connections activities accurately reflect the relevant primary connections units?

- **How did the activity conducted at discovery centre enhance the curriculum that you are teaching?**
- **Does the activity connect with the curriculum?**
- **Are the activities being conducted at discovery centre relevant to the Australian curriculum? To the primary connections units?**

All PSTs interviewed thought that the activity at DSTC was relevant to the Australian curriculum or AusVELS and to the Primary Connections units.

The PSTs and mentor teachers noted that the DSTC workshops represented good hands on learning, which provided the opportunity to explore concepts and was fun and engaging for the students.

Many PSTs were unaware of the Australian curriculum some of which didn't know that curriculum was governed from the federal government and implemented by the state government.

The mentor teachers that were interviewed thought that the workshops provided by DSTC connected to the Australian curriculum and the Victorian curriculum.

Question 2

How well do the Discovery Centre activities present the explore phase of the five E's

- **In your practice do the Discovery Centre activities fit in with your practice of the five E's?**
- **Do the Discovery Centre activities only focus on the Explore phase of the five E's?**
- **Should the activity only focus on explore or should the activity do engage, and explain as well?**
- **What would you change about the activity at Discovery Centre?**

All PSTs interviewed thought that the DSTC activities presented the explore phase of the 5Es model of teaching.

A large majority of the PSTs saw that activity as also covering some of the engage phase of the 5Es, with most saying that there was too much engage for an explore class. Most PSTs did note that through the program DSTC would not know exactly where the primary school classes were up to in the unit of work and would not be able to tailor the workshop to a particular class.

About half of the PSTs thought that the activity also covered some of the explain phase of the 5Es as there was some resolution to the explore phase and that the class was not completely free form exploration in the workshop. Some PSTs thought that the workshop should cover from engage though to explain, with the main focus on the explore phase activities.

Both PSTs and teachers noted that the activity does need to do some of the engage phase of the activity to spike students' interest in the workshop and to make tangible relations back to the engage phase activity they have already done in their classrooms. But there was mixed opinion on the use of explain in the workshops at DSTC.

Many PSTs reflected that there are no improvements to be made to the workshops at DSTC, which may have been due to the interview being conducted directly after the workshop not allowing PSTs adequate time to process the activity.

Many of the respondents said that the physical activity of the students in the workshop should begin sooner and that there was too much talking at the beginning introducing the topic. In many of the workshops that were preformed there were items on the tables of the activity and the PSTs noted that the students were distracted and wanted to play and as a result were not engaged during the introduction to the activity. Some of the responses also noted the suitability of the space for the workshop. In The Lab where some students were pulling on a rope connected by pulleys required a larger space than provided to ensure that the students were not going to go through the glass window.

As many of the classes were composite classes, there was discussion within a few of the PST groups about the level to which the activity was pitched and that there should possibly be some differentiation of some activities in the workshops for different age groups especially for the P-1-2 composite classes.

Question 3

What have the PSTs learnt from the discovery centre initiative? How does this inform their practice?

- **What did you learn from the activities conducted at the Discovery Centre?**
- **Does the activity you have done at the Discovery Centre reflect the content of your course at university? Why yes, why not?**
- **Do you think that the activity at the Discovery Centre is beneficial to your practice?**
- **What is different about the method of teaching at the Discovery Centre from your experience?**
- **Would you incorporate any of the methods at the Discovery Centre into your practice?**

The responses from the PSTs on this particular question was varied with many of the PSTs and teachers expressing their learnings from the experience were more than pedagogical knowledge.

The common themes from the PSTs expressed in what they have learnt were;

- The knowledge of how to teach science using the Primary Connections units and the 5Es model of teaching
- The examples of science that was conducted in the workshops were new to some of the PSTs and how students interact with that science.
- Some PSTs expressed that one of the key points that they learnt was the management of a class outside of the school environment i.e. on an excursion.
- Most of the PSTs noted that the students appeared to be more engaged and enjoyed the hands on aspect of the workshops than they expected.

The vast majority of the PSTs said that the LTDSI activities reflected the teaching of the Teaching Science course conducted at LTU. The PSTs found that the LTDSI was beneficial to their practice in learning how to conduct an excursion, as well as the demonstration of the 5E model, and the observation of the hands on learning style demonstrated by the DSTC during the workshops.

The PSTs and the teacher responses to the final question in this line of questioning noted that they would incorporate the experiments and hands on 'fun' learning approach to the explore phase of the 5E model of teaching into their teaching methods.

Question 4

What effect on the students' learning does the Discovery Centre have for a teacher?

- **Does the activity at the Discovery Centre help your practice?**
- **Do the students engage more with the content?**
- **Is there a difference in how you taught the unit of work at the school before and after the discovery experience?**
- **What impact did the activity at the Discovery Centre have on the classroom?**

The responses for this set of questions for the effect on the student for the teacher has the greatest number of responses from the teachers interviewed. The teachers noted that these workshops help them in the class room by enabling them to use reflective learning in their practice, and they could incorporate cross circular activities with these kinds of workshops.

The teachers also noted that their students engaged more with the workshops than they would have back at their school due to a variety of reasons. The main reasons being that the change in environment caused a higher engagement rate and the resources that are available at DSTC are better than those than can be easily sourced at their home school.

The PSTs and the teachers expressed that they would change their practice in how they would engage students with science content by incorporating some of the activities that were done at DSTC in their own classrooms.

One of the important impacts the DSTC workshop had on the students for the teacher is the students were more engaged with the topic and would be more willing to learn about the topic after their experience at DSTC.

Question 5

What planning and/or orientation activities were done with your students before the visit to the Centre? How did you collaborate with your mentor teacher?

There were varying levels of planning done with the students and mentor teacher before the DTSC visit and the workshop.

The amount of planning and other activities that were conducted prior to the DSTC visit increased from approximately half of the PSTs conducting pre-planning or visits in the first week of visits to all of the PSTs completing planning and teaching prior to the visit in the final week.

Initial responses from the PSTs noted that they were very unsure of what was required of them and their mentor teacher. As such some PSTs activity sought not to teach the engage lesson with their

class prior to visiting the DSTC and some mentor teachers did not know that they could offer the PSTs to teach their students.

After the first week of activity the PSTs showed a higher level of engagement with their mentor teachers prior to their DSTC visit. The activities that were carried out by the PSTs were;

- Meetings, emails and telephone calls to organise the logistics of the visit.
- Communication back and forth relating to the lesson plans for the engage phase lesson that they were going to conduct with the class.
- Team teaching (by the PSTs) or assisting the mentor teacher to teach the engage phase lesson in the school class either on the day of the visit or a few days prior to the visit.

Most of the PSTs at this point chose to teach the lesson at the school where they were able to.

Unfortunately there appeared to be some severe communications breakdowns in the process of the planning activities in the program. This was due to several reasons;

1. Some PSTs did not receive the required information from tutorial lessons at LTU.
2. Some of the mentor teachers did not respond to emails in a timely fashion.
3. Some of the mentor teachers and PSTs were not sure of the explicit requirements of the program and what was expected of them.

These factors caused a variety of problems when organising the activities on the day of the DSTC visit and the engage lessons prior.

Question 6

What were your expectations of what would happen at the Centre including your role there?

This question was asked during an introduction session to DSTC that was run a few weeks prior to the engage lessons with the classes.

Most of the PSTs thought that they would be taking the class, team teaching or helping to facilitate the class at the DSTC. Only a small number of PSTs were properly informed that their role at DSTC

was to work in small groups with the students in the workshops and that they would help the facilitator of the workshop in the small group work at the tables.

The PSTs expectations of what could happen at the DSTC was that students could develop ideas about science and do a lot of self-exploration at the DSTC. Many noted the planetarium and the vertical slide as activities to do at the DSTC and many identified with having fun at DSTC.

Question 7

What were your perceptions of your students' engagement and learning when they were at the Centre? What did you personally learn at the Centre? Was your role as you expected?

The responses from the interviews regarding the engagement and learning of the primary school students were that the students were highly engaged with the hands on aspects of the workshops while they were exploring the experiments. The majority of PSTs noted that the attention of the students to the demonstrations at the beginning of the workshops was low as there was equipment and lab materials on the tables where the students were sitting which caused the students to be more interested in the equipment than the demonstrations.

There were two flavours of responses from the teachers and PSTs on what they had personally learnt from the workshops at DSTC; the PSTs and teachers often didn't know about the particular activities or experiments that were conducted during the workshops, or the teachers and PSTs had a background in science learning or teaching and were aware of the experiments and activities and thus did not take a significant amount of personal learnings from the workshops.

The PSTs expectations of the roles that they would be fulfilling at the DSTC varied over the weeks of activities. In the first week the PSTs were very unsure of what they would be doing at the DSTC as they felt that the communication from the DSTC and LTU was not clear and succinct enough to allow them to know what they would be doing. After the first week the PSTs were communicating with each other outside of the program and letting each other know what to expect. The information that

the PSTs provided did not clearly indicate if any further information was coming from LTU with regards to informing the PSTs as to what they would be doing.

Question 8

What do you perceive to be students' learning gains from the Centre visit? Would you recommend more visits to the Centre (why/why not?)

There were several key learning gains from the workshops that were most commonly noted by the PSTs and the class teachers. The transfer of knowledge surrounding the content of the workshop was the key learning gain from the workshop, there were also secondary gains from the workshop which related to the change in perception of their view on science and scientists. The PSTs noted that students could identify concepts in their world experience, such as sound is everywhere and can be created from almost anything. Some of the responses also noted that the students gained the experience that science is not 'just explosions'.

There was no negative feedback from PSTs and Teachers when asked if they would come back to the DSTC for workshops, although most noted that some changes would need to be made to adapt the suitability to each individual class. Some PSTs expressed that they would not bring back students for the exploration of the exhibition floor for each visit as this caused the students to become too excited and the refreshing of the exhibits is not often enough if they were to come back every term. The PSTs thought that the experience was valuable enough to bring their own classes back to the DSTC when they became practicing teachers in order to access the resources that they would not be able to access otherwise, and to enable them to be more effective teachers of science (which they identified as not a teaching strength). They also thought that the experience was highly valuable for the students as the hands on engagement of the workshop enabled them to have better learning outcomes as expressed in the previous question.

During the course of this questioning the interviewer added the additional question for the teachers "Would you actively seek to organise funding for your own class if the workshops were not externally funded?" Not all of the teachers responded positively to this question as the work loads

are too high already to seek to organise funding for their class, but a number of teachers that were interviewed thought the experience was valuable enough to warrant the extra effort.

Question 9

What did you know about the Discovery Centre prior to the visit?

During the introduction session at the DSTC the PSTs were asked about their knowledge of the DSTC. Most of the PSTs who were local to the Bendigo region and were raised in Bendigo had come to the DSTC during their primary school years. These PSTs remember the vertical slide the most fondly and some of the exhibits.

The remaining PSTs did not know of the DSTC unless they had walked past the signage out the front of the Centre. Many of the PSTs that did not know of the DSTC claimed that this was due to not being local to Bendigo and had only recently, within 2 years, moved to Bendigo or were travelling for their study in Bendigo.

Question 10

What have you learnt about science teaching and learning from participating in planning and conducting this visit?

PSTs identified that they need to make the subject matter fun, in order for them to be effective in their practice of teaching science. PSTs also identified that the explore phase of the 5Es should be fun and hands on in order for students to be able to form ideas about the subject that they have not been introduced to yet.

PSTs identified that communication and a significant amount of planning is required to conduct excursions and activities that are not a part of regular class room activities. But PSTs were also able to see how the process was made easier by the use of Primary Connections units and using the resources available at the DSTC.

Question 11

What have you learnt from collaborating with your mentor teacher in organising and conducting this visit?

The key point that PSTs took away from the organisation and conducting the visit to the DSTC with the mentor teacher was that a large degree of communication was required and that they were not prepared for that.

The other points that PSTs learnt from the organisation and planning of the visit were that class management is different when outside of the classroom and that Primary Connections provides almost everything that is needed for teachers to be effective in their practice of teaching science.

Question 12

To what extent has this experience influenced your views about being an effective teacher of primary science in the future?

The few teachers that responded to this question found an enthusiasm for and wanted to teach science that they did not previously have. They also found how effective the hands on practical nature of exploration can be for students learning science.

The PSTs found themselves more confident in teaching science in the future where previously they would have had a light touch or avoided the topic in their practice.

PSTs also said that they would endeavour to make their science lessons fun and engaging with proper use of language and hands on experiences to make their students learn and love science more.

Summary of findings from Surveys

The PSTs and classroom teachers were surveyed over the period of 3 weeks after the program was completed using the ReMSTEP evaluation survey questions. There were 24 responses from the PSTs representing 17% of the student population in EDU2TS. There were also 12 responses from Teachers that participated in the program representing 29% of the teachers that participated in LTDSI.

Despite the low response rate of PSTs and teachers from the program, the following quantitative analysis of the program was supplemented by comments to the Likert style questions and open ended questions.

Each of the survey questions as described above is analysed below.

As a result of the REMSTEP activity:

Knowledge change:

1. I gained new insights into scientists' research and development practices and roles.

The PSTs had a mixed responses to question 1, with 63% responding positively to the question as seen in figure 1. Question 1 may have been ambiguous to the PSTs and teachers as the question is inquiring with respect to research and development practices. Which when viewing the DTSC workshop facilitator as a scientist may have made the question relevant.

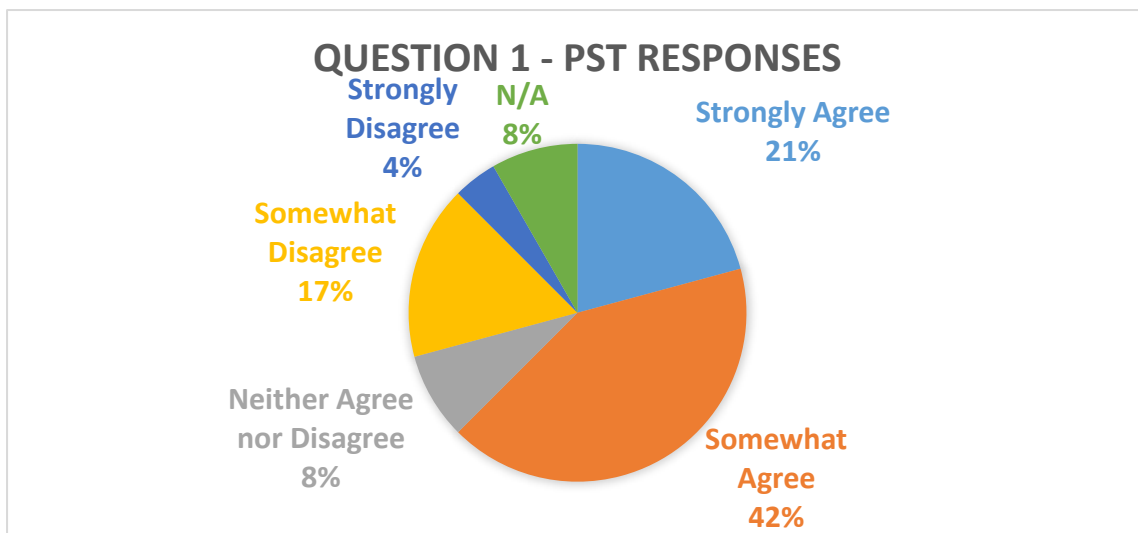


Figure 1 Likert scale responses from PSTs to question 1: I gained new insights into scientists' research and development practices and roles

The mentor Teachers by contrast to the PSTs responded quite negatively, shown in figure 2, to the question with 67% responding that they disagree, with 50% of all the teachers responded that they strongly disagree. This was supported by comments by the teachers noting that LTDSI did not have scientists involved with the process.

A second comment made by a teacher who responded strongly disagree noted that the program was not what was promised in the beginning and that the PSTs did not provide anything more than a single lesson.

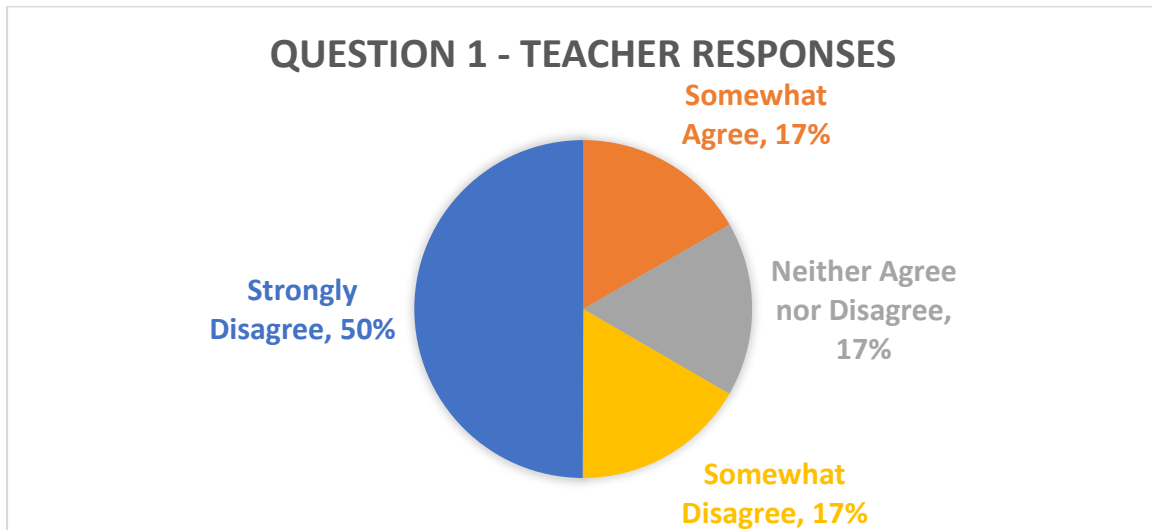


Figure 2 Likert scale responses from teachers to question 1: I gained new insights into scientists' research and development practices and roles

2. My perceptions of scientists as people changed in a positive way.

PSTs showed a mostly positive response to question 2, figure 3, with 55% responding agree or strongly agree, and 29% neither agree nor disagree. This as in question 1 may have been due to the phrasing of the question with regards to perception of scientists.

The supporting comments made by PSTs to this question noted that scientists are more normal people and that being a scientist is less unattainable, but also some PSTs responded that they knew that scientists were not "bald men with glasses". A response that eluded to the PSTs thinking of their tutor for EDU2TS as being the "scientist" for the question was that one PST commented that the tutor was "brilliant, and I have a positive ideas on how to run science lessons in the future".

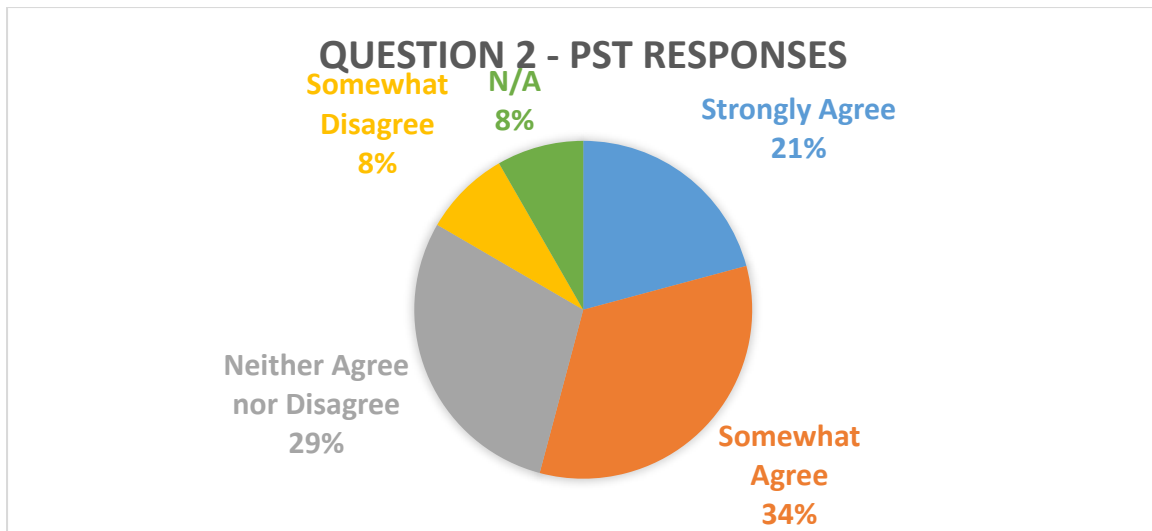


Figure 3 Likert scale responses from PSTs to question 2: My perceptions of scientists as people changed in a positive way

The mentor teachers responded with 42% strongly disagree, this was supported by a comment “Actually feel annoyed and disheartened with the whole project as it was organised so differently from what we were told. I would never have anything to do with this project again”.

The contrast to this sentiment was that a teacher had a positive perception of scientists prior to the program.

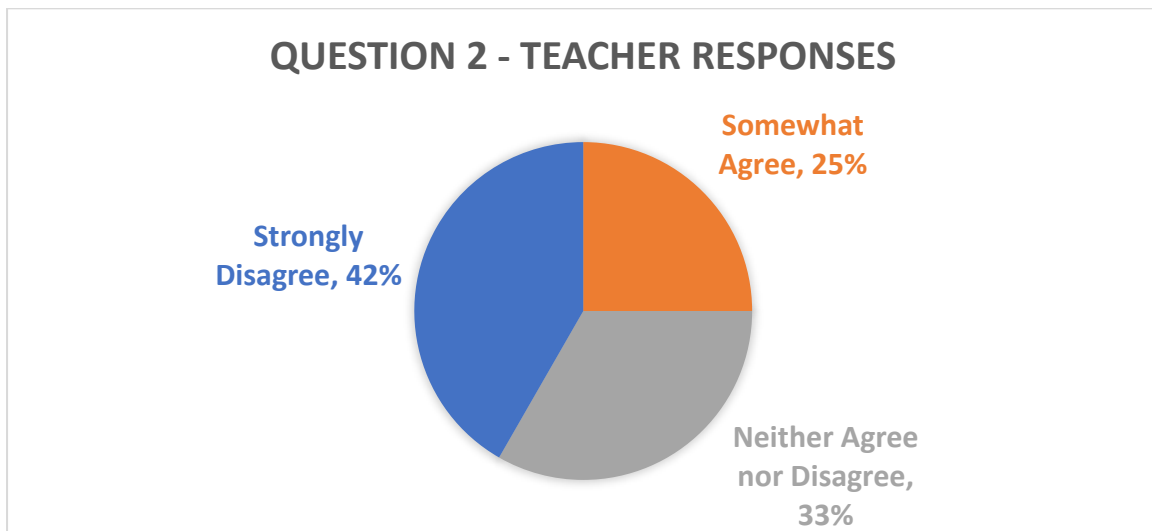


Figure 4 Likert scale responses from Teachers to question 2: My perceptions of scientists as people changed in a positive way

3. I learnt some useful and interesting science concepts.

As noted in the interview responses and the reports the PSTs learnt some useful and interesting science concepts from LTDSI with 88% responding agree or strongly agree, as shown in figure 5.

Comments from the PSTs to this question noted that the workshops for the explore phase activities and exhibitions on the floor at DSTC have valuable content. One PST commented that they learnt “very interesting concepts, particularly around using analogies in the classroom”.

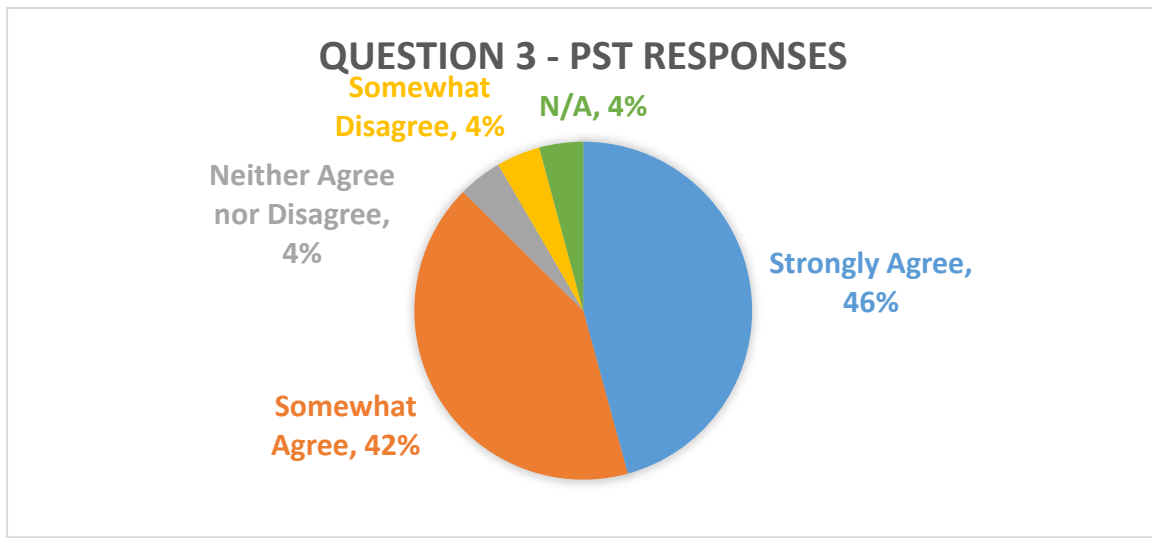


Figure 5 Likert scale responses from PSTs to question 3: I learnt some useful and interesting science concepts.

The classroom teachers overall responded with 42% strongly disagree, figure 6. They noted in their comments that the DTSC were great and the lab was interesting but they did not personally learn any content that they didn't already know or find interesting.

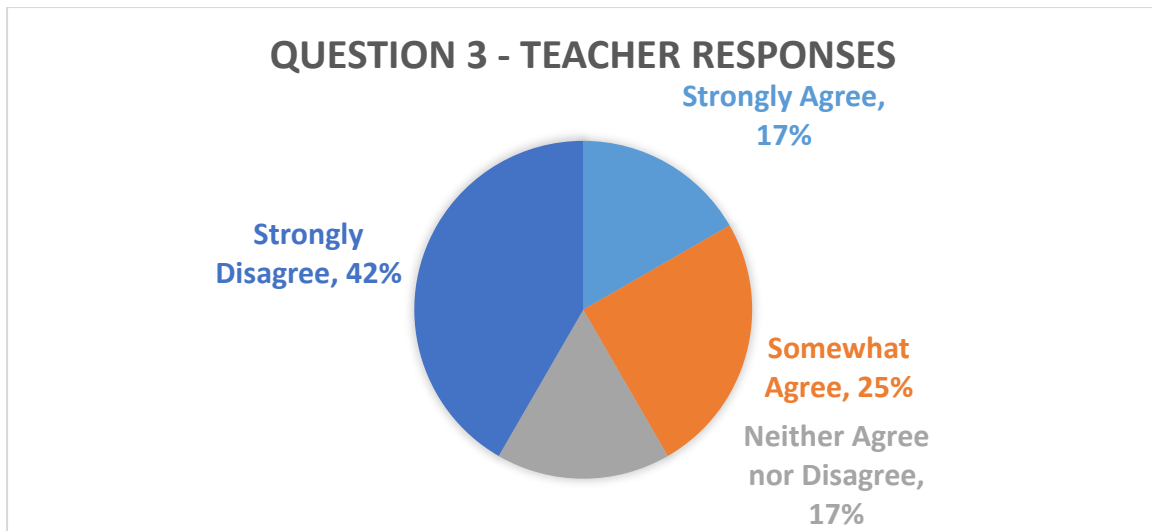


Figure 6 Likert scale responses from Teachers to question 3: I learnt some useful and interesting science concepts.

Attitude change:

4. There has been a positive change in my attitude towards science and/or teaching science.

88% of PSTs responded that they found they had a positive change in attitude towards science and/or teaching science. With the remaining PSTs neither agreeing nor disagreeing on the question. See figure 7.

The PSTs commented “5 E’s was great as was collaborative learning, and science Centre’s importance.” And “My perceptions and attitudes toward science were fairly positive to begin with and have not changed dramatically.” This shows that most PSTs became more confident in their attitude to science and/or teaching science.

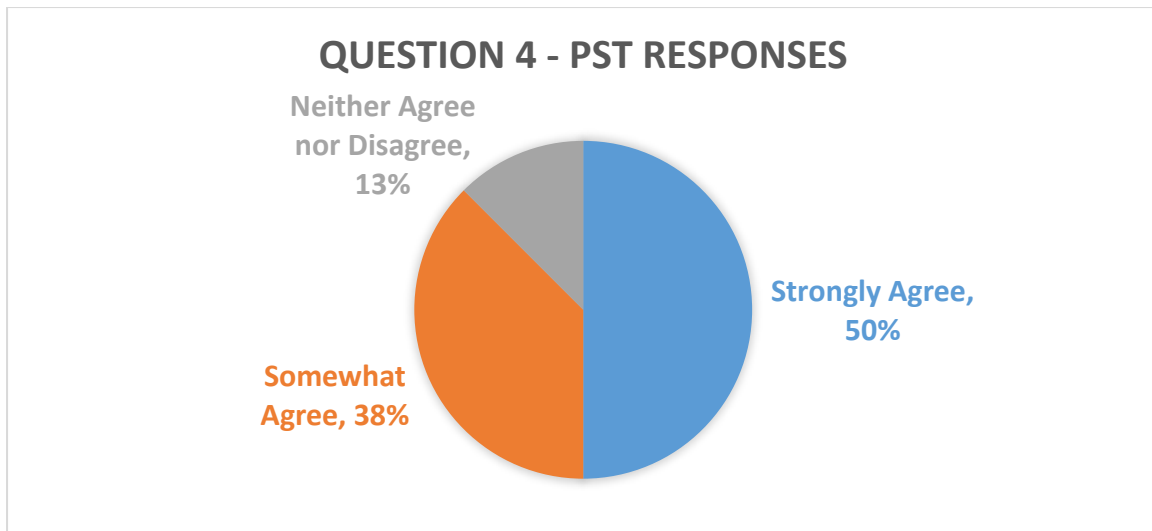


Figure 7 Likert scale responses from PSTs to question 4: There has been a positive change in my attitude towards science and/or teaching science.

One of the teachers commented on question 4 with “The way the program was handled, the misinformation and the lack of interest by my group of students did not cause a positive change and I would be very reluctant to try the program again. However I love teaching science and will continue with this.”

This aligns with the responses from teachers of neither agree nor disagree or strongly disagree, figure 8.

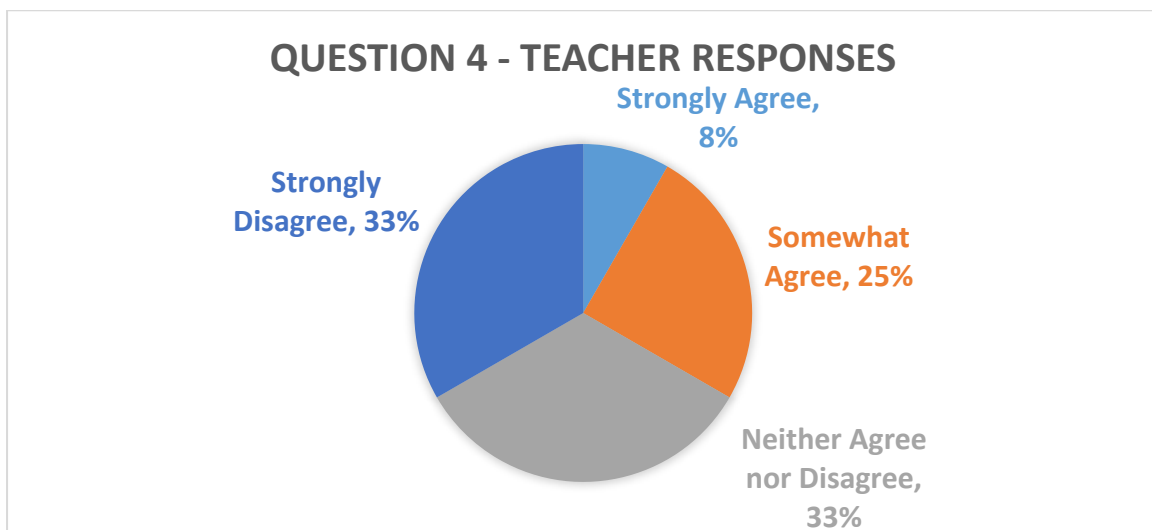


Figure 8 Likert scale responses from Teachers to question 4: There has been a positive change in my attitude towards science and/or teaching science.

Practice change:

5. I was engaged in new and interesting approaches to teaching science

Question 5 had an overall positive response from the PSTs, figure 9, supported by comments from the PSTs.

One PST commented “Loved the 5E approach. Very hands on and helpful!” and another commented “The staff conducting the workshop that I was able to observe (I had my session cancelled) was not demonstrating all that we were taught through the subject however it was interesting to observe”.

Given that the subject ‘Teaching Science’ is based upon the 5Es model and this for most of the PSTs is a completely new concept, the responses from the PSTs, to question 5, would give the idea that the LTDSI was new and interesting to the PSTs.

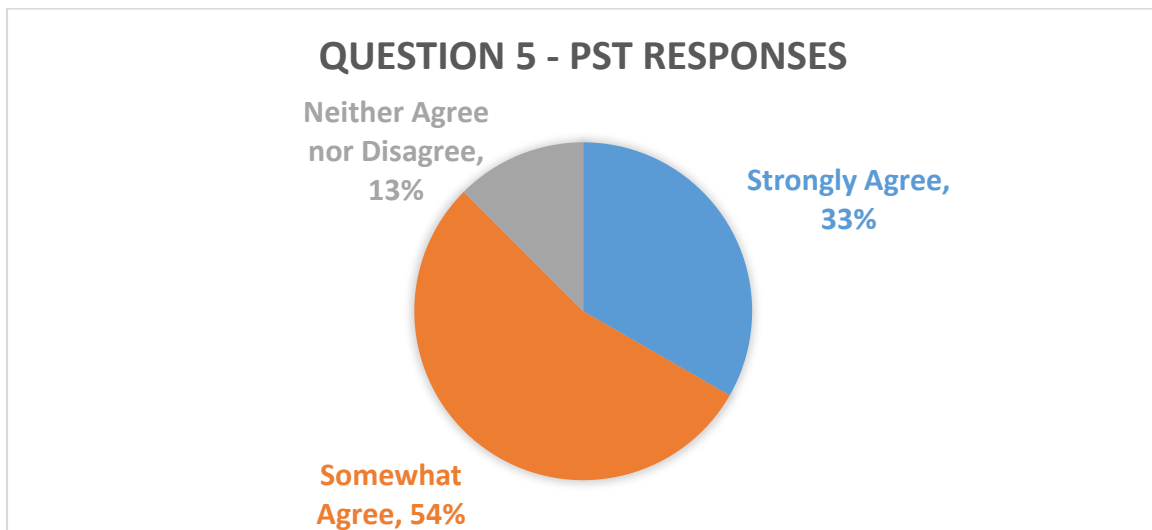


Figure 9 Likert scale responses from PSTs to question 5: I was engaged in new and interesting approaches to teaching science

The overwhelming majority of the mentor teachers disagreed with this question. This could be due to the approach to teaching science using the 5Es model is a standard model for teaching for those classroom teachers already. Thus this would not be seen as new approach to teaching science.

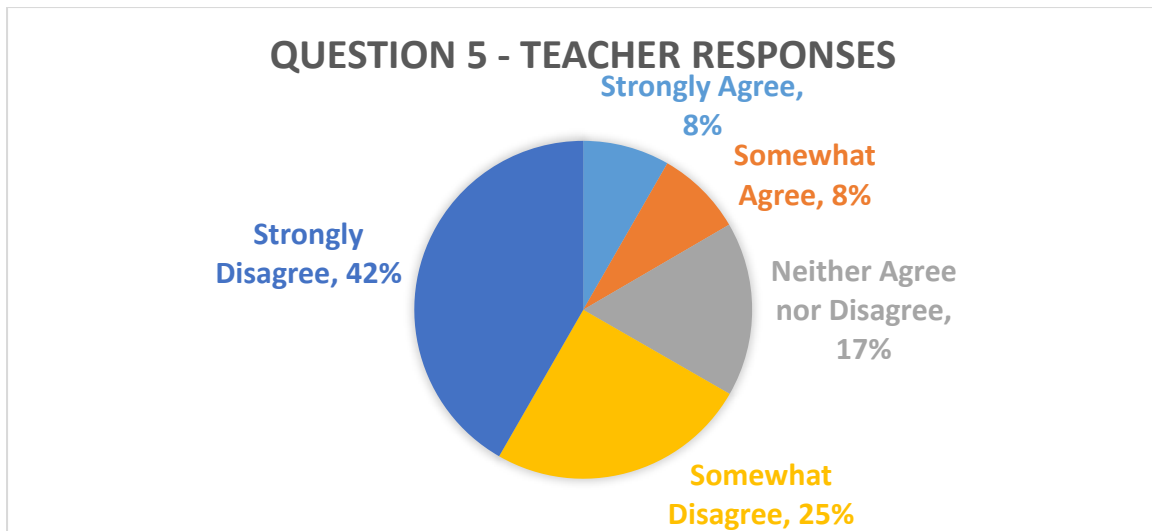


Figure 10 Likert scale responses from Teachers to question 5: I was engaged in new and interesting approaches to teaching science

6. I have learnt things about engaging with contemporary science that will influence my teaching in the future

Only 12% of PSTs responded that they will not be influenced in the future from engaging with contemporary science though the LTDSI program. Figure 11

The comments from PSTs for question 6 include; “I really loved the Primary Connections teaching unit” and “I am aware that the 5Es is a valuable framework to teach and allow students to build on prior knowledge and test predictions etc.”

This shows that the PSTs have engaged with the subject matter and have found the information useful enough to think that they will be influenced in the future because of the program.

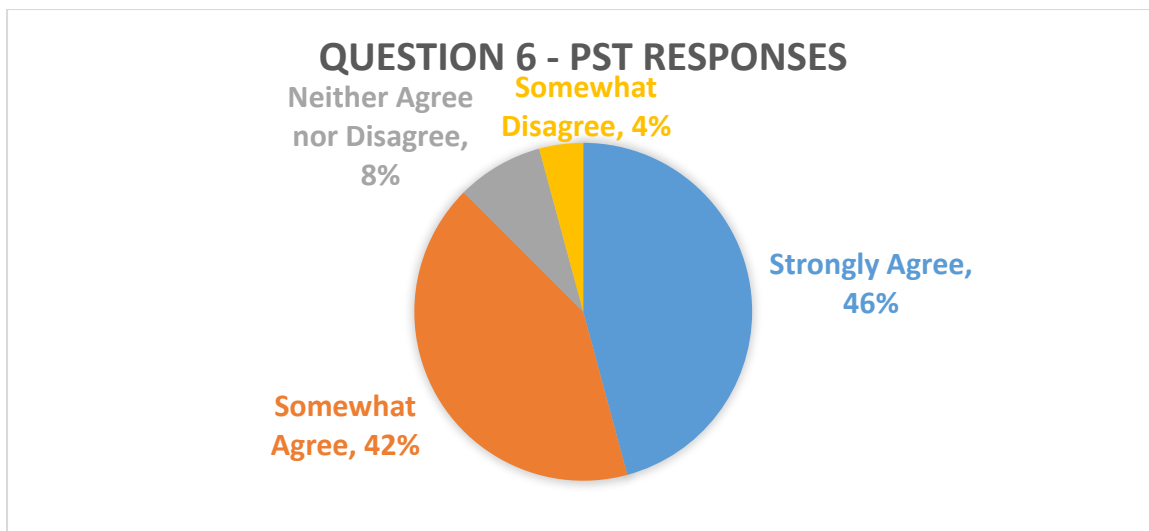


Figure 11 Likert scale responses from PSTs to question 6: I have learnt things about engaging with contemporary science that will influence my teaching in the future

The mentor teachers responded 42% strongly disagree, 33% somewhat agree and the remainder, neither agree nor disagree on question 6, figure 12. There were no comments left from teachers as to their reasoning for their answers.

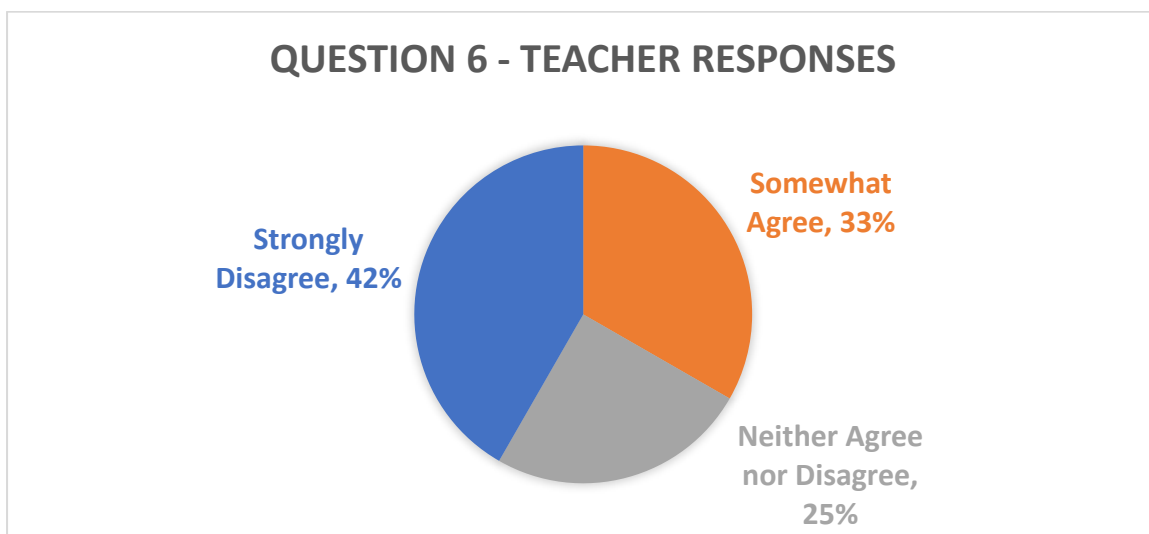


Figure 12 Likert scale responses from Teachers to question 6: I have learnt things about engaging with contemporary science that will influence my teaching in the future

7. I gained ideas for how to bring contemporary science practices into the school curriculum

For question 7, the PSTs responded with 91% either somewhat agree or strongly agree. The single comment from a PST was "There has been some information and content given to us that will help me with science in my future classroom however there is much more of the curriculum that I would like to know how to implement in engaging way".

This would imply that the PSTs did not address how to implement all of the curriculum in an engaging way using the 5E model of teaching. Although this is the only written comment that was made to the question out of 24 responses.

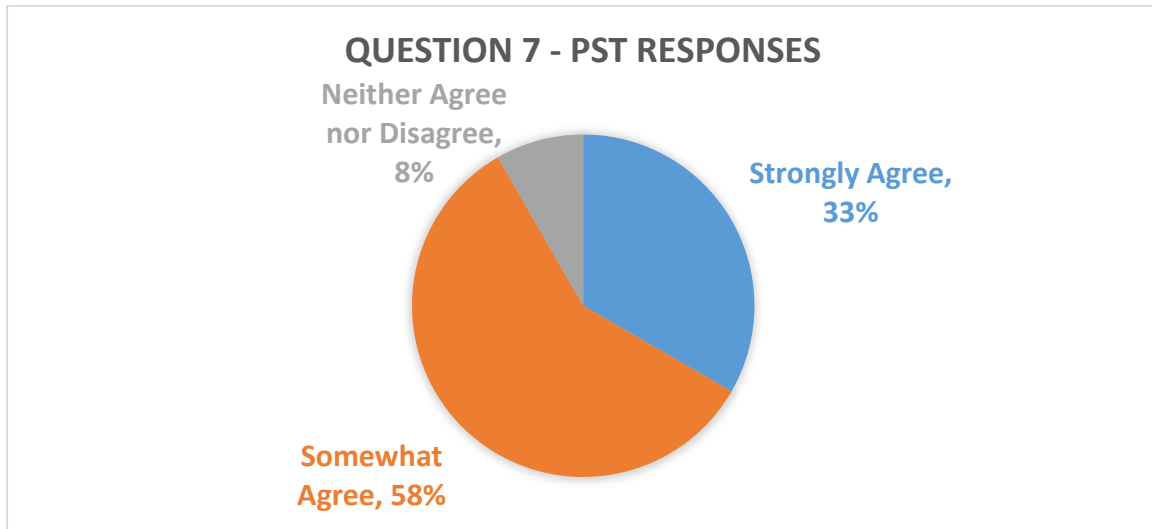


Figure 13 Likert scale responses from PSTs to question 7: I gained ideas for how to bring contemporary science practices into the school curriculum

The teachers responded fairly evenly to question 7 with 50% either somewhat or strongly disagree and 42% somewhat agree, with 8%, neither agree nor disagree. As with question 6 there were no written comments to question 7 to derive any extended meaning from their responses.

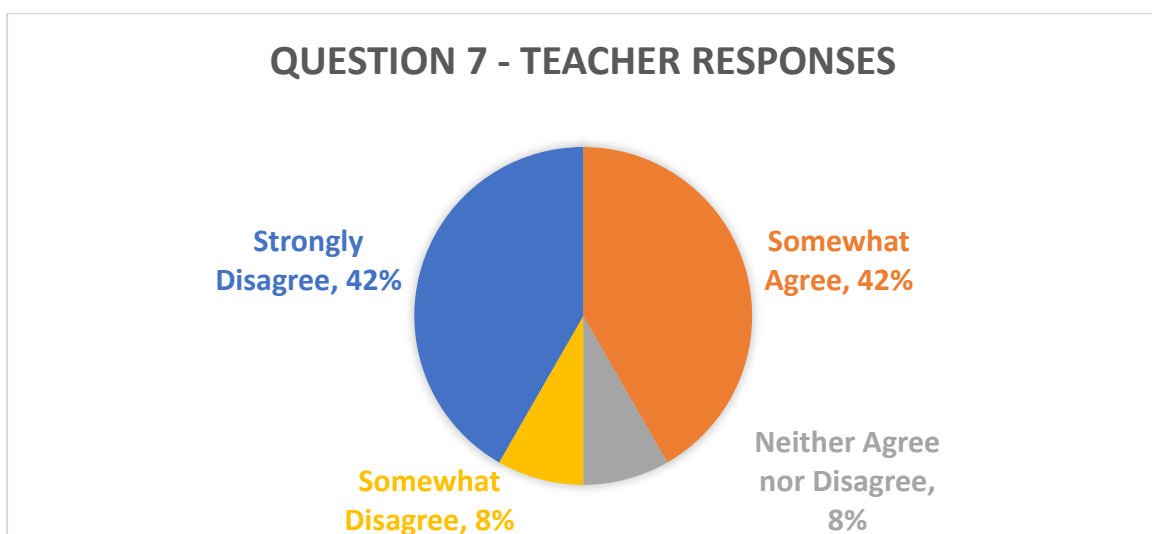


Figure 14 Likert scale responses from Teachers to question 7: I gained ideas for how to bring contemporary science practices into the school curriculum

Changes in students' engagement, attitudes:

As a result of my students' involvement in the REMSTEP activity:

8. Students developed new understandings of the nature of scientific practices

Overall the PSTs either somewhat or strongly agree with the statement that “Students developed new understandings of the nature of scientific practices”, figure 15. The two responses from PSTs noted that they were not able to observe the DSTC workshop, which accounts for the 8% of N/A responses for this question.

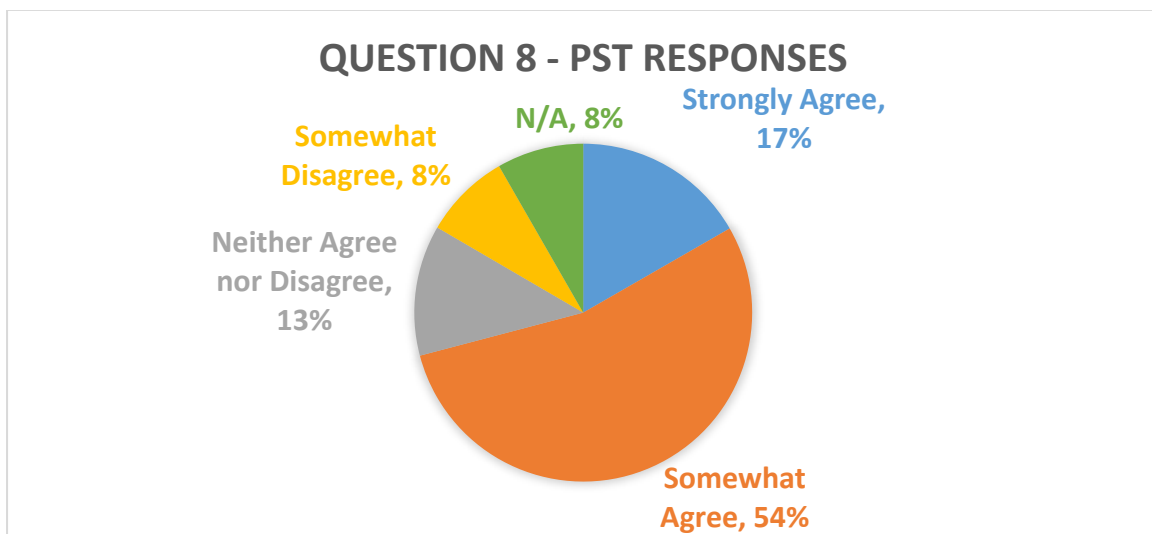


Figure 15 Likert scale responses from PSTs to question 8: Students developed new understandings of the nature of scientific practices

By contrast to all previous questions the teachers responded positively with 58% either somewhat or strongly agreeing to the question, figure 16. This was supported with two comments “My class enjoyed the student teacher lesson - the two students who came (was meant to be four!!) did a great job” and “Through their own experimental play on the activities in the Discovery Centre and through their classroom experience at the Centre. My student teachers showed initiative engaged with the students and explained concepts to them as they interacted with the experiments”.

This supports the idea that the teachers thought that LTDSI was a positive experience for their students in learning science.

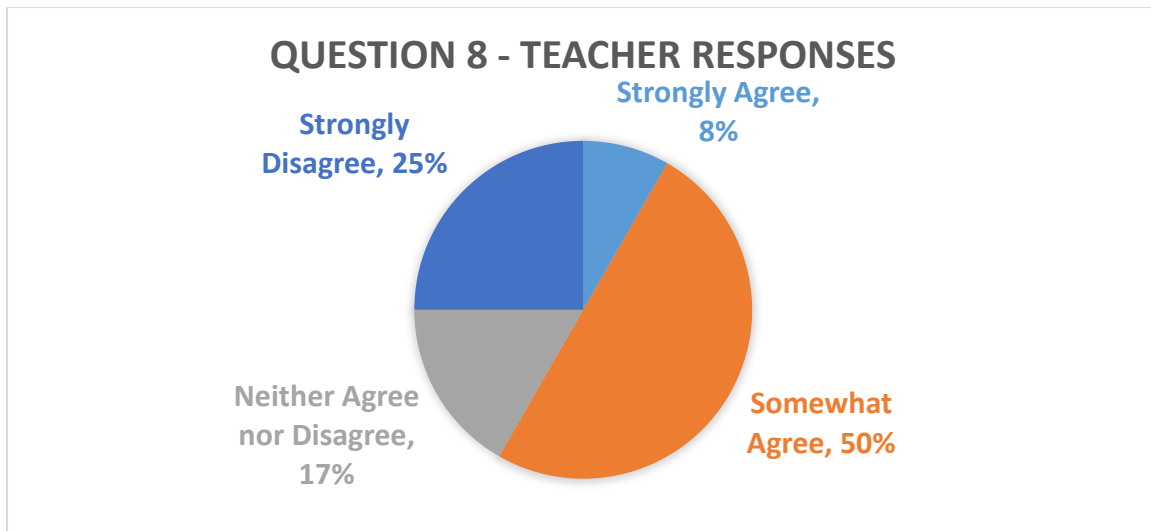


Figure 16 Likert scale responses from Teachers to question 8: Students developed new understandings of the nature of scientific practices

9. Students were productively engaged with learning science

The PSTs responded very positively to question 9, there were some comments from PSTs that noted that the students were excited to be doing a new concept and engaged with the hands on nature of the activities. There were a couple of notes to be considered from the PSTs, they were; students got bored with some of the activities in the workshops after a while and while the students were on the exhibition floor at the DSTC, because the PSTs and teachers were not able to extend the learning with the exhibitions on the exhibition floor.

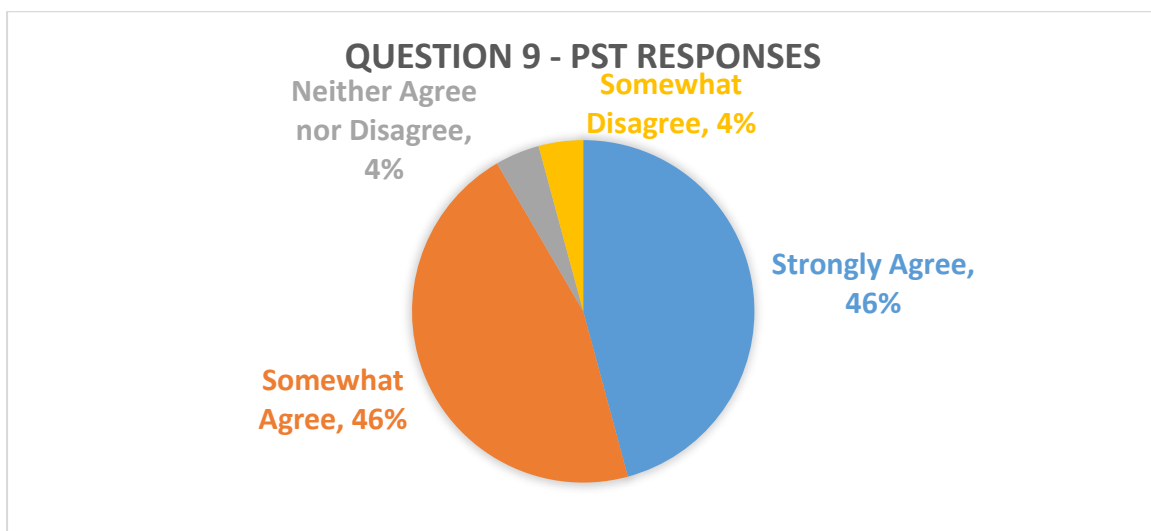


Figure 17 Likert scale responses from PSTs to question 9: Students were productively engaged with learning science

The overall responses from the mentor teachers for question 9 was that they agreed with the statement “students were productivity engaged with learning science”. See figure 18.

There were a few comments from the mentor teachers for this question; two of the teachers found workshop conducted at the DSTC was well organised and that the students enjoyed the workshop. One of the teachers commented negatively that the “lesson that was not organised or appropriate for the grade level”

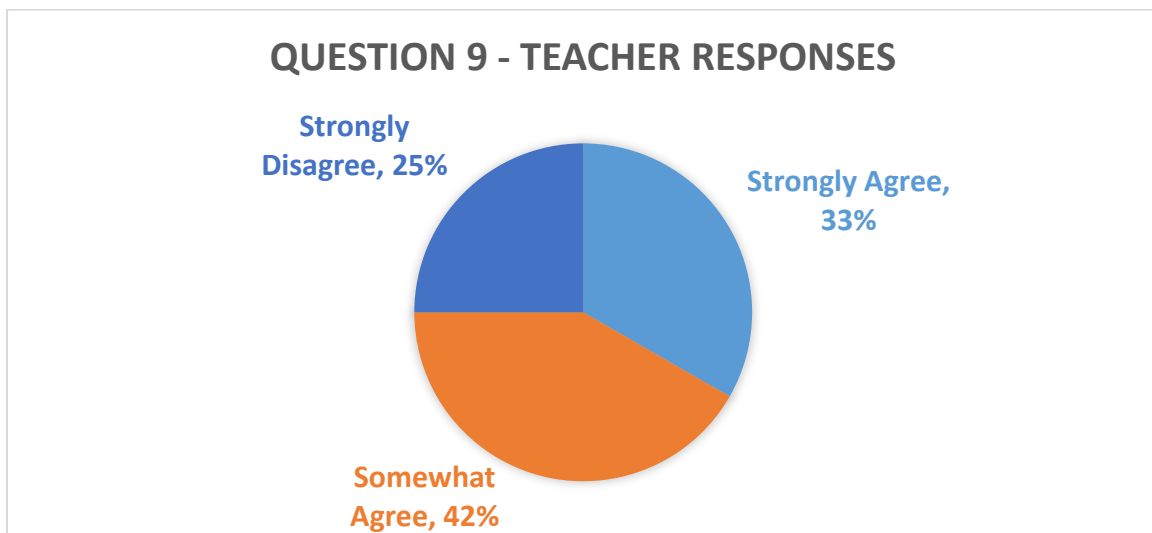


Figure 18 Likert scale responses from Teachers to question 9: Students were productively engaged with learning science

10. These activities featuring contemporary scientific practices positively impact on students’ engagement with science.

PSTs responded with 91% somewhat or strongly agree to question 10, figure 19. The comment from a PST noted that the students were engaged and curious about the topic that they were learning, but some students found the concepts hard to comprehend, although they were still interested in the activity.

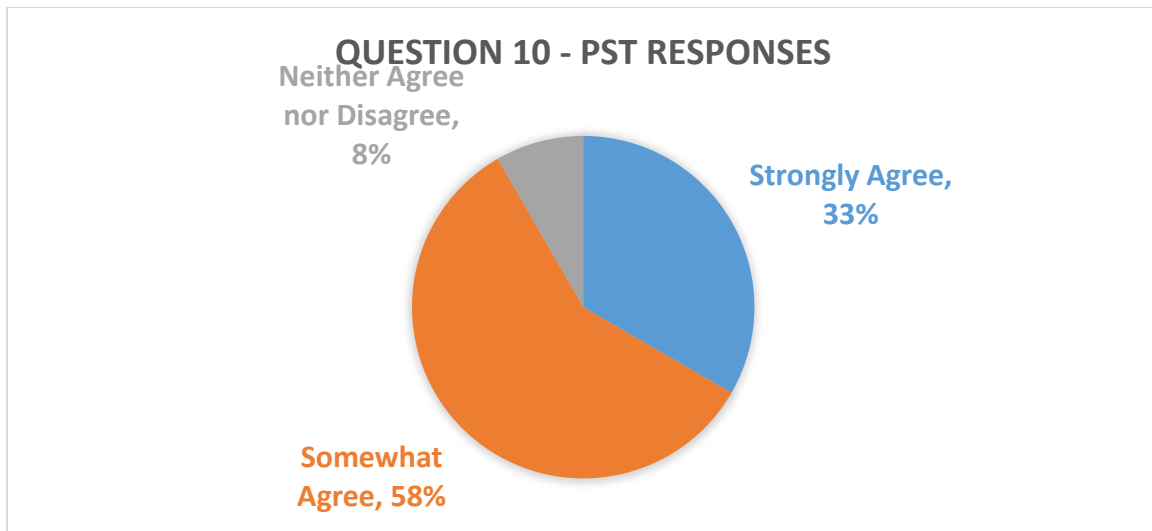


Figure 19 Likert scale responses from PSTs to question 10: These activities featuring contemporary scientific practices positively impact on students' engagement with science

Teachers overall agreed with question 10: These activities featuring contemporary scientific practices positively impact on students' engagement with science. The two comments from teachers noted that the students liked the DSTC activities and the engage lesson that the PSTs did at the school.

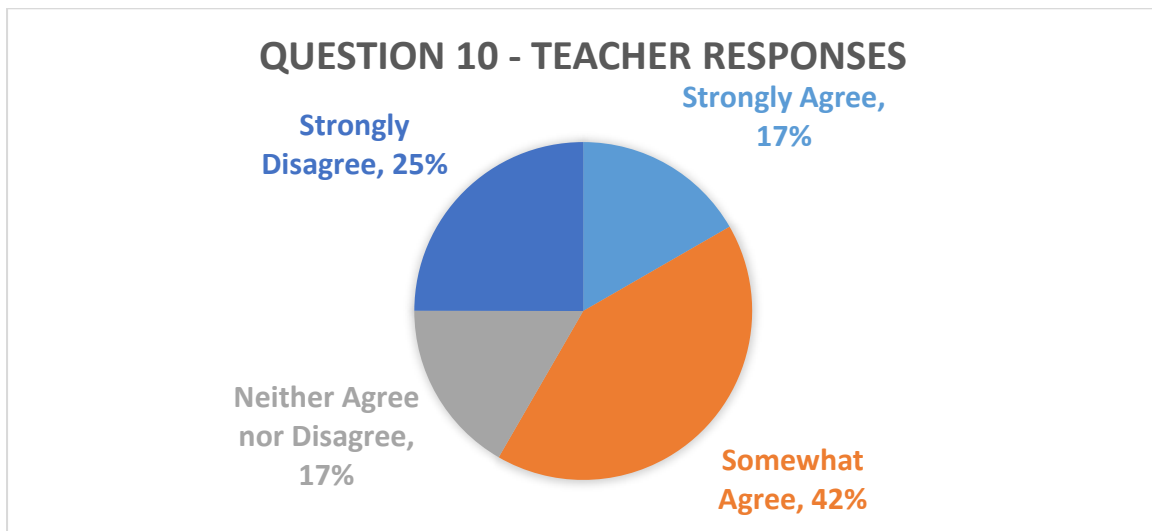


Figure 20 Likert scale responses from Teachers to question 10: These activities featuring contemporary scientific practices positively impact on students' engagement with science

11. Overall, I felt the REMSTEP activity worked well.

There was an overall response that the LTDSI worked well see figure 21. The comments from the PSTs noted that the communications issues experiences throughout the program were a problem

which resulted in some groups of PSTs missing out on the DSTC excursions and workshops. Other comments from PSTs noted that LTDSI was great for the primary school students to get hands on, and experience and explore science, but could have been better with improved communication between LTU, DSTC, the schools and the PSTs.

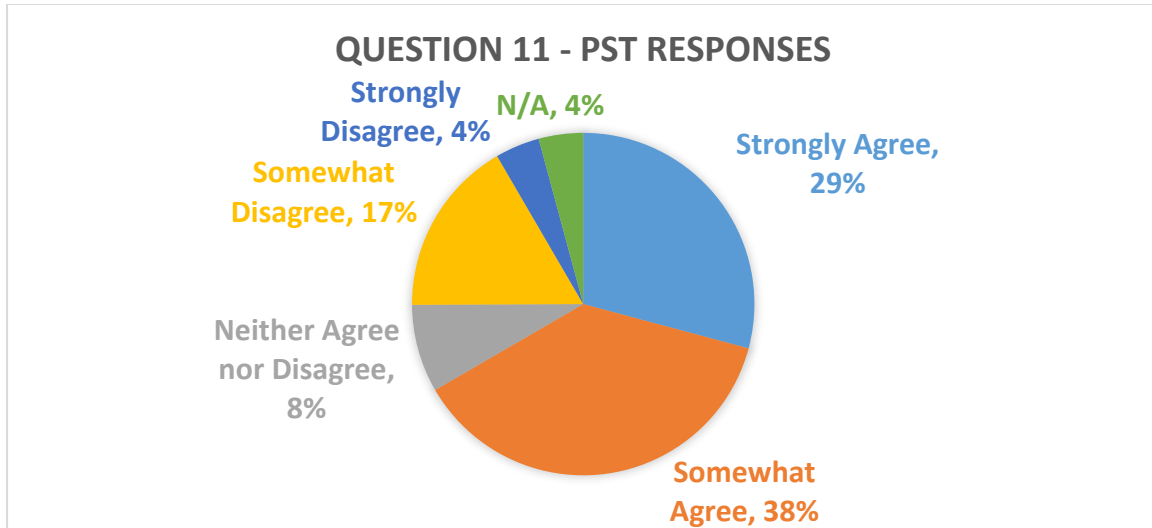


Figure 21 Likert scale responses from PSTs to question 11: Overall, I felt the REMSTEP activity worked well.

The mentor teachers were split equally between strongly disagree, neither agree not disagree and somewhat agree with 33% of responses each. The comments from the mentor teachers for the LTDSI program were critical of the communication issues and expressed negative views of the program because of those issues.

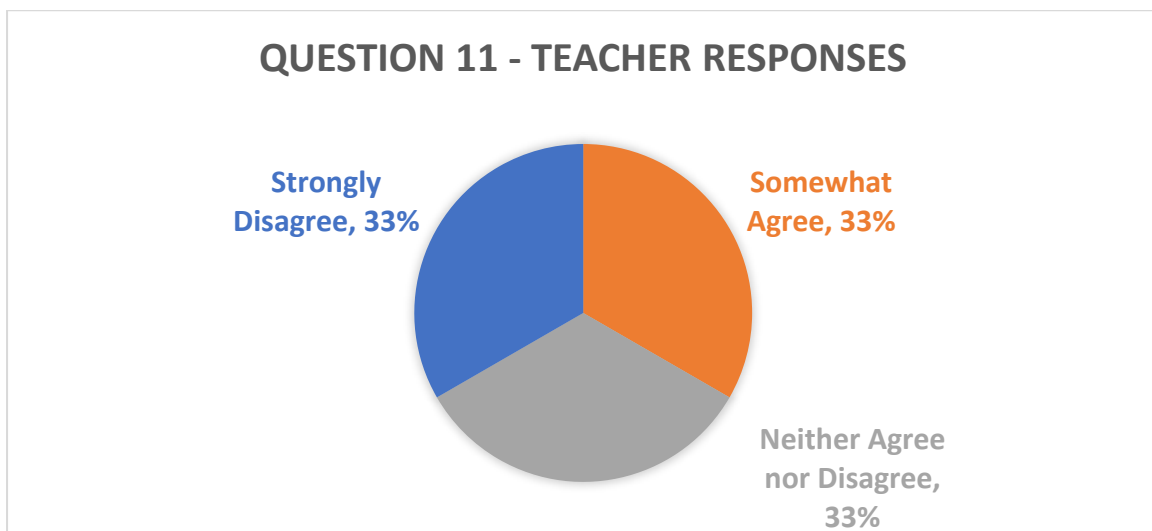


Figure 22 Likert scale responses from Teachers to question 11: Overall, I felt the REMSTEP activity worked well.

Ideas for improvement

12. What were the challenges for you in these activities?

The most common response from the PSTs for question 12 was that communication issues were the biggest challenge in the LTDSI. PSTs felt that no one was on the same page about what was going to be conducted at the DSTC and if PSTs were required to take the lesson at the school and organizing the time for the lesson at the school to take place. There also appeared to be a knowledge issue with the PSTs as they did not know enough about the activities and exhibits to be helpful to the students as well as not knowing the students enough to be able to deliver content and control the class during the lessons. A response that was given from a few of the PSTs was that the group nature of the program made the process harder as some PSTs were not as reliable.

The teacher's main challenges from the LTDSI were that the PSTs were not well prepared in their engage lessons and the communication of what was expected of the PSTs to do in the classroom and what was going to occur during at the DSTC as well as the time that the workshop was going to occur. This lack of communication caused some classes to miss out on going to the DSTC. The timings of the activities at the DSTC could have been improved to allow more time in the workshop and for all students to get to go on the vertical slide. One of the other challenges for teachers was the sourcing of equipment and materials for the classes.

13. What aspects of the activity were particularly helpful?

The aspects that the PSTs found to be the most helpful were the Primary Connections materials, being able to take the engage lesson at the school and being exposed to the DSTC workshops. The PSTs found that they became more confident in teaching science and that they are fonder of science than they previously were. The scaffolded approach to the Primary Connections and the 5E model also helped the PSTs in their assignment.

The mentor teachers found the activity at the DSTC was the most helpful in engaging the students with science. They also found the hands on nature of the engage lesson that was planned by some of the PSTs and the explore phase lesson at DSTC to be helpful. There were some responses that noted that the program was not helpful at all and that without the teacher's input the engage lesson that was planned by the PSTs would not have been suitable.

14. What do you feel you gained from the activity?

The PSTs found that their biggest gains were in confidence to be able to teach science to primary students, as well as being able to use Primary Connections and the 5E model of teaching. They also found that one of their gains was that they now know how to make science fun and engaging for students.

The teachers found that they gained frustration and distress as they do not believe that they received what they were sold, and that they had to plan a unit of inquiry without planning time. The positive comments that the teachers had in terms of their gains from the activity was that they had a renewed enthusiasm for science, and the visit to the DSTC.

15. What changes would you suggest to improve the activity?

The most common response from the PSTs for improving the LTDSI activity was improving the communication between DSTC, LTU, PSTs and the schools. They felt that this was the biggest let down of the program and that the learning outcomes could have been improved for both the students and the PSTs themselves if this was improved. Other ideas for improvements from the PSTs were that DSTC needs to cater more to each individual class and that they should provide an "exhibits cheat sheet" for the PSTs and teachers so that they can help facilitate learning on the exhibition floor. One of the other comments that was made by the PSTs for improving the program was that the mentor teachers need to be in full support of the PSTs and the program in order to make LTDSI successful.

The mentor teachers noted that the changes they would make to make the program more successful would be to improve the communication between all parties, and make sure that the PSTs know what they have to do in the DSTC and the classroom as well as making them teach the class in the classroom. The teachers also commented that the timings need to be improved as some classes got more time than others in the lab. A couple of the teachers noted that they were promised a unit of work and that one engage phase lesson and a trip to the DSTC was not enough to justify their time and effort.

16. What support would be needed for teachers to use these resources?

The PSTs commented that what is needed for teachers to use this resource was communication and a detailed explanation of what was to be expected.

The mentor teachers commented that the support that is needed for this program to work would be clear expectations and materials to use in the school environment.

Summary of findings from PST reports

The PSTs were required to produce a report for formal assessment for the course Teaching Science (EDU2TS). The following evaluation was produced from Part B of their report, found in Appendix A, which were personal reflections upon the program and their work. Each section details common themes and personal points of view that were commonly found across the entire cohort of PSTs under evaluation.

Question 1

Reflect on the effectiveness of the 5E model in planning and teaching your science unit.

Most PSTs reflected positivity upon the 5E model of teaching in their planning and teaching of their respective primary science unit.

The PSTs in general thought that the 5E model provided a scaffold that is structured enough that they can effectively plan and execute a science unit even if they are not confident in their own

content knowledge. They also found that the model is flexible and can be tailored to the particular school and class through the use of formative and summative assessment. The assessments inform the teacher about the knowledge and capabilities that are existing and have been developed through the course of the unit of work.

Some PSTs found the engage phase lesson hard to implement as they felt that they should be correcting misconceptions that the students have in their knowledge base through the lesson, instead of listening and allowing engagement to form and then correcting misconceptions in the later phases of the 5E model.

Many responses stated that they would incorporate the 5E model outside of the science domain and include the model as a key pedagogy in their teaching practice across all domains of teaching.

There was a theme of responses that showed that the PSTs were learning the science themselves through this method of teaching and this assignment. PSTs stated that they were more confident in their ability as teachers, especially in teaching science. This was due to the self-explanatory method to planning and executing lessons that is implemented through the 5E model, that has a particular focus on hands on learning and 'fun' that their students enjoyed more than typical delivery of science.

Question 2

What have you learnt, what would you do differently if you did this again?

The key learning outcome from the LTDSI and EDU2TS was the 5E model of teaching science. Most of the PSTs did not know of the 5E model prior to LTDSI and the ones who did know the pedagogy had come across the method during their teaching practicum.

Many PSTs were surprised by the engagement from the students in the engage and explore lessons, as many PSTs had negative views on science as a result of their own educational experiences. The

PSTs found that their students were highly engaged and excited to learn about science, to the point where some students were enquiring if the PSTs would be coming back to teach them more.

A lot of PSTs learnt how powerful and informing, formative and summative assessment is for structuring a series of lessons around the 5E model. As the assessments allow for the lessons to be tailored to the particular class of students. This was found to be particularly important as many PSTs were surprised by the variation of knowledge and skill levels at the primary school level.

For the engage and explore lessons the PSTs learnt about the need to have their lessons tailored to the class to ensure that they are not covering material that is already known or too advanced for the students. They also found the need for scaffolding of the engage and explore phase lessons to lead the students in the right direction on the topic and not allow the students to simply play with the activities and get them to learn about the concepts under investigation. They also thought that their engage and explore phase lessons should be hands on and engaging to 'spike' their engagement.

The 5E model provided PSTs a model to allow them to plan a series of lessons, instead of planning individual lessons in isolation, which is what they had previously done in their experiences. They found that the Primary Connections units need to be tailored to the particular class that they are teaching, which the PSTs found easy when using the 5E model.

The PSTs also stated that they found that they need to know more about the topic under investigation by the students in order for them to be able to answer student questions. Although the PSTs thought that the answers to the students' questions were well within their ability to learn.

There were many details that the PSTs thought that they would do differently if they were to conduct the activity again. The most common aspect they would do differently was the communication between LTU, DSTC and the primary schools which needed to be increased, such that everyone was on the same page with respect to; PSTs taking engage lessons, the timings and the kinds of activities that were going to be done in the workshops at the DTSC and their roles at the

DSTC. The PSTs also thought that there needs to be more communication between the individual classes and the DSTC so that the engage phase lessons could be developed to lead into the explore phase workshop at the DSTC to ensure that the workshop was not too low or high level in relation to the students' knowledge and skill, in order to maintain the engagement of the students. The PSTs also wanted more information on the students they would be teaching to be able to provide a better educational experience in their lessons as many planned a lesson that was not as engaging as the lessons should have been.

Many of the PSTs said that they would have liked to do an entire series of lessons to cover all of the phases in the 5Es not just the engage and explore phases. They believe that they and the students would have learnt more from completing the whole process than just a part of the process.

The PSTs would have also liked to be more informed from LTU with regards to how much planning, communication and the length of the lead times that would be required for the activity. As many PSTs underestimated the amount of coordination and time that the program would take.

They also suggested that the time the students spent on the exhibition floor would have been more valuable if the students were in small groups on a guided tour of all of the exhibits, as much of the time spent on the exhibition floor was simple playing and not engaging with the exhibits or learning from them. They thought that this would be especially valuable if some of the exhibits were incorporated into the workshop that was going to be conducted by the DSTC.

The PSTs pointed out that the workshops that had many activities should have a leading question or two at each station to lead the discussion and activity of the students in order to make the learning outcome more specific and in depth. A few PSTs also requested more strategies in how to lead discussions and questions so that they can guide the students to an answer to change their misconceptions and answer some questions that they don't know the answer to.

A few PSTs also wanted to do more than one engage and explore lesson to allow more time for the students to develop their own ideas about the concepts that were being covered before moving on to other phases of the 5Es.

Question 3

How have your views of teaching science changed as a result of this experience?

The overwhelming response to this question was that PSTs have a dramatically improved view of science as a subject as well as an increased level of confidence and enthusiasm in teaching science at primary school level. This increased confidence was attributed to the structure provided by the 5E model, the Primary Connections resource and their DSTC workshop experiences.

Many of the PSTs reported that they had disengaged with science as a student many years ago and felt a large degree of trepidation in having to teach the subject. They viewed learning science as memorising facts, theories and procedures, and felt pressure as a teacher to know all of the answers. However after planning and teaching science lessons a common realisation was that science can be simple, fun, engaging and relevant to students' lives. In addition PSTs came to understand that in teaching science lessons teachers are more important to facilitate learning, exploring and questioning than to have all of the answers and that a teacher's knowledge can develop alongside their students'. Some PSTs also recognised that this understanding can be transferred to other subjects.

The importance of the hands on nature of the activities was continually mentioned. The activities were seen to have a positive impact on student engagement which helped maximise the learning outcomes as students became self-motivated.

There was new found enthusiasm expressed for teaching the subject with some PSTs being determined to make the science classes they deliver more engaging and fun through the use of hands on activities than they remember their science classes being when they were a student. PSTs

recognised that the teacher's positive attitude towards a subject and the subject's content is conveyed to their students and that children gaining scientific literacy is an asset that should be valued.

Question 4

Provide a brief overall reflection (general and science based) about your experience.

The reflections of the PSTs clearly show an overwhelmingly positive response to the experience of the LTDSI program.

Through the application of a wide range of formative and summative assessment PSTs were able to conclude that student learning outcomes were generally met. Types of assessment specified were questioning, class discussion, use of vocabulary, roleplays, journal entries, annotated drawings, and students' ability to apply new knowledge to their own lives as well as participation and engagement.

The importance of assessing the prior knowledge of the students was acknowledged by PSTs as important as formative assessment allows the identification and correction of misconceptions of knowledge, as well as giving the teacher the ability to tailor the content of their lessons to their students.

Those who felt they didn't meet all of their learning objectives reflected that poor time management and inadequate planning of their lessons and also their lack of familiarity with the needs of individual students limited their success. Some PSTs met with the classroom teacher beforehand and greatly benefitted from the information gained such as individual students' needs and problematic groupings.

The experience of the practice of teaching science in the LTDSI program was seen as positive and not as intimidating as anticipated. The use of Primary Connections and the E5 model helped the structure and engagement of the lessons as well as providing the PST with confidence in teaching the topic.

The engagement provided by the hands on nature of the engage phase lesson and the explore phase excursion to DSTC helped achieve learning outcomes as students were able to apply new knowledge directly to aspects of their lives. In addition PSTs also reflected that the inherent curiosity of children makes teaching them science easier than other subjects they have had experience with.

Summary of Findings from Observations

The summary of findings from observations are key observations that were noticed by the evaluator, Nick Tran, through the observations of DSTC in particular the workshops performed in the Lab and Auditorium. The observations also extend to the PSTs and their performance and trends that became apparent over 3 weeks of observations.

Discovery Science and Technology Centre

For all of the workshops conducted by the DSTC during the course of LTDSI there were 4 facilitators of the workshops. While most of the workshops ran successfully without any problems, differences in the facilitators and their delivery of the workshops was noticed. However this was not perceived to be an issue, the key issue was that the content that was delivered was different between facilitators.

Where some facilitators would introduce vocabulary during the introduction of the lesson, some would introduce more theoretical information and others would introduce both but not in the detail the others would. This is important as many teachers and PSTs noted that these classes can be cross curricular, especially with the use of “scientific” words which can be incorporated into word walls and literacy classes.

The Primary Connections units and the curriculum are separated into each grade level, many classes that visited the DSTC were composite classes with the largest span of three years from Prep to grade 2. This presents a potential issue with the delivery of the workshops whether using the Primary Connections framework, AusVELS, or Australian curriculum, where some of the concepts that were being introduced were too advanced or basic depending on the student that was involved in any particular composite class. While variations in content knowledge is common between students in a

single grade level class, the physical abilities and dexterity of some students in a composite class made activities in the workshops more difficult to complete.

Many of the PSTs and teachers noted and the evaluator also observed that the lab at the DSTC was at times very loud with the sounds of other students playing on the exhibition floor, as well as the water vortex machine whirring next to a large open window in the room. This caused quite a bit of distraction to the students in the workshops and many comments to the effect of 'when will this finish I want to go and play' were heard while the students were distracted in the lab. Further distraction was apparent with many activities beginning with the materials on the workshop tables when the students came into the lab. While the introduction to the lab was taking place many students particularly on the boundaries of the room and not directly in front of the facilitator were distracted by the materials and were more focused on them than they were on the introduction to the workshop.

The introduction to each of the workshops was found to be good in the delivery of content even though there were variations found. Unfortunately for many of the younger grade levels the introduction was too long to maintain the students' full attention to the facilitator which may have caused some of the above mentioned issues.

Some occupational health and safety issues were noticed in the beginning of the evaluation, these were immediately raised by the evaluator to the DSTC staff and while many of the issues may have been minor they could have had serious outcomes should an incident have occurred.

While some timing considerations needed to be made to ensure that the running of the program was successful, the timings of the sessions should be better considered in the future. Some of the workshops ran for 45 minutes while other workshops ran for 20 minutes for the same content, this would not give the same educational outcomes as the 45 minute session. When this was coupled with the need for 3 classes to have a workshop each in a two and half hour session, the students would spend too much time on the exhibition floor and would come into the workshops over

aroused, hard to manage and distracted which resulted in diminished learning outcomes from the workshop.

The evaluator also noted that the students were highly engaged once the activity during the workshops began. All workshops allowed for engagement and exploration of the ideas that were presented to the students. Even if this engagement was briefer than expected there appeared to be enjoyment and learning occurring.

Through many discussions between the evaluator, the PSTs and the classroom teachers, there appeared to be positive thoughts and feelings towards the DSTC and the workshops, and many PSTs and teachers said that they would come again.

Pre-Service Teachers

The PSTs appeared to evolve over the three week period of the evaluation of LTDSI. This is most likely due to the PSTs talking and collaborating with their peers during tutorials, lectures and outside of formal classes. This was evident in the approaches that the PSTs were taking, where in the beginning of the program the PSTs were hesitant and unwilling to do some activities such as taking the engage phase lesson. Many PSTs did not know the requirements of the program, such as they should be taking the engage phase lesson and not leaving the lesson to the mentor teacher, and that they would be helping facilitate small groups in the workshops at the DSTC.

As the weeks progressed there appeared to be less apprehension to the program from the PSTs and that they were more willing to get involved with the students.

During the time where the students were exploring the exhibition floor, either before or after their workshop at the DSTC, about half the PSTs would engage with the students and help them explore the exhibits and facilitate their learning. The other half of the PSTs kept to themselves and didn't have much engagement with the students. The PSTs that did not engage with the students were also the PSTs that were highly critical of the program and were the unsure of what they were meant to do.

From the learning management system (LMS) logs of the EDU2TS LMS webpage only 101 PSTs of the 147 PSTs accessed the run sheets that were provided by DSTC for the PSTs during the course of the LTDSI program. The logs of the LMS website for EDU2TS would appear to show that not all of the relevant material was viewed by all PSTs with enough lead time to ensure that they knew what was expected of them, nor was enough time given to them for some materials for the PSTs to be adequately prepared for the program. This may have led to many of the comments surrounding the unorganised appearance of the program and communication issues that were apparent. PSTs not receiving the required information in a timely manner and then communicating this to the mentor teachers may have further exacerbated the problem.

From the interviews with the PSTs over the course of the program, the PSTs appeared to be more comfortable with the idea of teaching science during their teaching practice. Many PSTs stated that they were now not afraid of the concepts of science at a primary school level and that they would have actually had a renewed interest themselves in learning about science.

La Trobe University

The organisation of the program was not as organised as what was necessary to have the program run completely smoothly without issues. This as previously mentioned was caused by many communications issues between LTU, DSTC, PSTs and the schools. Looking upon the lecture slides provided on the LMS page and other content posted, there was not enough lead time for PSTs to organise themselves sufficiently to be able to perform at their best when LTDSI activities began. Explicit details of what was to occur between the PSTs, schools, and DSTC was not available to the PSTs, and DSTC did not provide sufficient induction to the PSTs during the introduction session of what will be happening at the DSTC as they were not informed of what they needed to provide. While this was slowly corrected over the course of the program it hampered the program and led to much of the negative feedback that was received from all parties.

During the interviews of the PSTs the interviewer asked if the explore phase activities link to the Australian curriculum, many PSTs were unsure of this and referred to AusVELS, which is in the

process of being phased out, and at the state level is being replaced with Victorian Curriculum. This leads to the assumption that the current subject matter that is being taught is out of date. As second year education students will not be teaching under the AusVELS curriculum when they graduate university.

Many PSTs also noted during their interviews that as some of the PSTs were in third year of their studies and they were using lesson plans provided in other course materials from other subjects, that the lesson plans were not allowed to be used in that particular format for EDU2TS, which created some annoyance amongst the PSTs. While this should not present an issue, this may be a cause of annoyance amongst some PSTs in the natural requirement to then re-format the work.

• Recommendations

The recommendations that are presented here are based upon the evaluation findings and suggestions made by various parties throughout the LTDSI program.

Recommendations for Discovery Science and Technology Centre

Recommendations to DTSC that would address many of the negative evaluation points found in the evaluation sections of this report that would improve the LTDSI are:

- During the induction session with the PSTs prior to the beginning of the program, clearly describe what the role of the PST is and what activities are going to be conducted during the workshops that are being run.
- Depending upon the topic that is being investigated by the primary school class, give a guided tour of the exhibits on the exhibition floor that are relevant to the unit of work. In lieu of this provide cheat sheets to the mentor teachers and PSTs to allow them to guide students through the exhibitions.
- For the workshops that are being conducted at DSTC, they should be more standardised with regards to the learning outcomes that are being provided to students. This standardisation may include; vocabulary, content, and activities. Use the Primary Connections units to develop a workshop for each Primary Connections unit, and tailor each workshop to a variety of classes. I.e. sounds like for Prep, Grade 1 and Grade 2. As well as composite classes to ensure that outcomes are met for each level of the Australian Curriculum.
- As there is an engage phase class that is occurring before the DSTC visit, work with the PSTs to make sure that the DSTC is aware of prior knowledge and ability of the students and that the level of the workshop is tailored to the needs and knowledge of the students.
- Due to the large variation of the workshop length and issues with students missing out on activities such as the vertical slide, only have one or two classes per session. This will ensure

that each class gets adequate time to engage with all activities and the workshop without having too much waiting time.

- As the world becomes more litigious, develop risk assessments and safety protocols for all workshops to ensure that safety requirements are met and can be produced to teachers upon request to satisfy school requirements.
- While there was pressure to get all school classes in during the allotted time, if there was to be a similar or larger number of students, run the LTDSI over a longer time to allow for more flexibility of class timetables and school schedules.

[Recommendations for La Trobe University](#)

Recommendations to LTU that would address many of the negative evaluation points found in the evaluation sections of this report that would improve the LTDSI are:

- Organisation was the biggest downfall of the LTDSI from both PSTs and mentor teachers point of view. This would be overcome by clear information being provided from LTU to PSTs and mentor teachers from the beginning of the program detailing; when activities were going to take place, who was expected to take the engage phase lessons, what was to occur during DSTC visits, and what the assessment criteria was. Also detailing the expectations of the PSTs, with regards to teaching engage phase lessons and helping small group work at the DSTC during the workshops.
- All the information for the PSTs to complete this assessment task needed to be provided in a more coherent format than what was done during the pilot program, with much more lead time than what was provided. This could take the format of a dedicated section on the LMS page for the LTDSI program, with all primary connections units, run sheets from DSTC, timings of activities and classes, as well as well as expectations of the PSTs and assessment criteria of their work. This would ideally be provided to PSTs at least 1 week prior to the DSTC induction session.

- Subject matter of the education course should be updated such that references to the Australian curriculum or the Victorian curriculum are used as the AusVELS curriculum is now out of date and the second year PSTs will not be teaching under the AusVELS curriculum.
- As a matter of standardisation all assessments where materials take a standard format, such as lesson plans, should be the same across the education subjects to avoid miscommunication and confusion of requirements to PSTs and to make marking of assessments more standard. I.e. lesson plan proformers that are provided in first year should be the same as those used for assessments in fourth year.

Recommendations to Schools

The recommendation based upon the evaluation detailed in this document for schools and their teachers are;

- Clear and concise communication of needs and requirements of students for the specific classes that need to be taught by the PSTs and the DSTC. Where there is correct matching of topics of what is being taught in the classroom to what the PSTs come and teach and what workshop is conducted. As well as travel requirements and timings such as being required to be back on school grounds by 12:30 pm.
- Open engagement with PSTs allowing them to take the engage phase lesson in the classroom or be assisted by the mentor teacher in the classroom, and the teacher giving open and honest feedback upon the preparation work and classroom teaching conducted by the PSTs.

• Conclusion

The key purpose of the *La Trobe Discovery STEM Initiative* was to improve the competence and confidence of pre-service teachers in teaching science at the primary school level. This has been achieved for a large portion of the pre-service teachers, with 50% strongly agreeing to the statement “There has been a positive change in my attitude towards science and/or teaching science” and 38% somewhat agreeing during post activity surveys.

Through the extended evaluation of *La Trobe Discovery STEM Initiative* by way of interviews of pre-service teachers and mentor teachers that participated in the workshops, observations of the workshops and the interactions of pre-service teachers and students, post activity surveys of teachers and pre-service teachers, several key themes emerged.

The program can be improved overall; the execution of the program and the benefits to the mentor teachers was not fully realised and resulted in poor survey results despite very good results from pre-service teachers. This was mostly due to organisational and communications issues between *La Trobe University*, the schools and their teachers, the pre-service teachers, and *Discovery Science and Technology Centre*, where all parties were not working perfectly in concert.

To improve the outcomes for all parties and to improve the workshops conducted by the *Discovery Science and Technology Centre* recommendations are put forth based upon the evaluation conducted in the preceding section of this report.

• Acknowledgements

I would like to thank all participants in the *La Trobe Discovery STEM Initiative*, including the pre-service teachers, the mentor teachers that are in the classrooms of Lighting Reef Primary School, Camp Hill Primary School, Quarry Hill Primary School, and Eaglehawk Primary Schools' and their associated leaderships, the EDU2TS: Teaching Science subject co-ordinators, lecturers, and tutors.

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- Appendices

Appendix A – EDU2TS Assessment Task 2 Journal, proforma for report

Appendix B – Discovery Centre workshop materials provided to PSTs



School of Education

EDU2TS Assessment Task 2 Journal

Team Members:

School: _____

Title: *(OF YOUR UNIT)*

Contents:

PART A: GROUP PLANNING AND REFLECTIONS

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Possible Science Misconceptions	2
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PART B: INDIVIDUAL REFLECTIONS

Overall View of Science Teaching	8
Critical incident	9

Note:

1. Only one team journal is submitted.
2. The team journal must be submitted as a single document.
3. Each member must complete Part B individually and add these to the team journal.

PART A: GROUP PLANNING AND REFLECTIONS

UNIT OVERVIEW	
Title:	
Focus:	
Year Level:	
Student Team:	
School:	
Teacher:	
Introduction	
<i>Give a brief introduction to your unit</i>	
Key Understandings from Science	
<i><Summarise, in dot points, the key concepts that are being covered from Science></i>	
<i>eg.</i>	
<i>The Key concepts being covered in this Unit are:</i>	
<ul style="list-style-type: none"> • <i>(Refer to The Science Continuum, AusVELS Science, Sample Science Program, Skamp, etc.)</i> 	
Possible Science Misconceptions	

<Summarise the key science misconceptions that you may encounter in teaching your unit: (Refer to *The Science Continuum, Skamp, Driver et al., etc.*)>

Actual Science Misconceptions

<Summarise the key science misconceptions that you encountered your class:>

Unit at a Glance*

Topic: <Insert your topic name>		
Phase	Lesson	At a glance
ENGAGE		
EXPLORE		
EXPLAIN		
ELABORATE		
EVALUATE		

*One Page Maximum – similar to Primary Connections Units

Log*

Stage	Team Members			
	W	X	Y	Z
Pre-planning				
Discovery				
Write-up				
Other (describe)				
Signatures:				

*All contributions including scribe, teaching, planning etc, should be noted in the log and signed off by all members prior to submission. This table should be no longer than a page.

Engage Phase: Prior Understanding Sheet – to be completed by the team following observation/feedback from classroom teacher on Engage activity/activities

Topic:

Year Level:

a) What were students' reactions to the activity?

b) How do you know what the students actually understand?

What is your evidence (diagnostic assessment)?

c) PLANNING SUGGESTIONS FOR DISCOVERY

Topic Suggestions

Identify one possible learning focus (or more) related to topics in Victorian Curriculum/AusVELS Science

List of possible resources, materials and information.

List of possible activities

Discovery Lesson

Group Planning Date

Topic

1. Group Planning

Participants

(a) Learning Focus related to the Victorian Curriculum/ AusVELS

Students will be able to:

This will be evident when:

(b) Children's prior understandings

What were the children's prior understandings in this topic?

How do you alter your lesson at Discovery to allow for these prior understandings?

(c) What Formative Assessment will we do?

2. Lesson Plans

Follow the protocol set out in the La Trobe Practicum Manual

Completed Lesson Plans attached

You need 3 lesson plans:

- 1. Engage phase lesson plan conducted in the host school environment.**
- 2. Explore phase lesson conducted at Discovery Centre Bendigo.**
- 3. Elaborate phase lesson plan that includes a novel technology component.**

PART B: Individual Reflections (i.e one per team member)

NAME:

Overall View of Science Teaching

Reflect on the effectiveness of the 5E model in planning and teaching your science unit.

What have you learnt, what would you do differently if you did this again?

How have your views of teaching science changed as a result of this experience?

Provide a brief overall reflection (general and science based) about your experience.

General:

<Did you effectively meet the objectives of your lesson>

<How effectively did you use assessment in your lesson and unit?>

Science:

Appendix B – Discovery Science and Technology Centre Explore Phase Workshop Run sheets
Look Listen – Grade 1



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Sounds Like...

look and listen to the world around us

In this workshop, students explore simple instruments to discover and make observations on sounds. By making their own instrument with simple materials, they will be empowered to use their imagination and make many instruments of their own.

Key communication messages

Sound is VIBRATION that moves through stuff. Vibrations move through the air to our ears and the inside of our ears vibrates which we "hear" as sound. This sound can be AMPLIFIED by making more things vibrate. The shape of the vibration gives us the PITCH of the sound.

Introduction

Ask students:

- What are sounds that we can hear?
- What is a quiet sound?
- What is a loud sound?

Presenter demonstration.

Activity

Rotating tables of three different instruments (about 2 minutes at each table):

- *Whirling sound tube:* The air vibrates through this tube, making the sound. As the tube speeds up, the vibrations change so we get a higher PITCH.
- *Clothes hanger on string:* Sound is VIBRATIONS through stuff. The more stuff there is to vibrate, the better the sound. This is why sound travels better through solid things than air.
- *Slinky cup:* Sound can be AMPLIFIED by spreading the vibrations. Think of a guitar, the strings are laid across a large box that allows for the sound to vibrate through it, making it louder (it vibrates more of the air than the strings do alone).

Build a clucking cup:

- Using simple materials, students will use amplified vibrations to make a noisy instrument that they can play



Conclusion:

What do the students observe about their instruments: how do they work?

We can change the pitch of our instruments by changing their shape – which changes the shape of the vibration.

Presenter Demonstration.

Notes





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Push and Pull

observing how things around us move

This workshop uses a variety of activities to illustrate forces in a fun and interactive way. By rotating around the room to use various sets of equipment, students use play to learn about Newton's laws of motion.

Key communication messages

Something standing still will need a push or a pull to make them move. A push or pull on something already moving will make it accelerate. However, when you push or pull something, it pushes or pulls back on you!

We can change or control these movements by friction (which can prevent things from moving) or simple machines like levers and pulleys (which can change the magnitude and direction of a force).

Introduction

Presenter demonstration: moving a chair and riding skateboards.

Activity

Students, in six groups, rotate around various activities (presenter to explain each station):

- Lever – we'll find out which point it is easiest to push down so as to lift someone up.
- Friction board – try pushing on blue side, on clear side, on tubes. Which is easiest?
(No riding/sitting/standing on board)
- Magnets
 - Try different ends. Do they push apart or pull together?
 - Horseshoe – push apart or pull together? Now turn the other way.
- Pistons: what happens when you push on this end? Or pull on an end?
Does it make a difference if the pistons on either end are different sizes?
(Don't pull them all the way out)
- Pulleys – Which is easier?
- Sumo balance point: gentle push with feet together, then feet apart. Which easier to push over?



Conclusion

Discussion of activities: what new discoveries did people make? What did you observe?

Safety Considerations

- Lever
 - Students fingers' getting trapped/squashed. Ensure students are monitored at all times.
- Pulleys
 - Students getting too enthusiastic and falling over. Ensure students are monitored at all times.
- Friction board
 - Students riding it and falling off. Explain no one is allowed to sit or stand on the board at any time.
- Sumo balance
 - Students getting too enthusiastic and pushing each other hard. Explain that this activity works best when we are gentle.

Notes



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Going Through a Phase

Identifying the properties of solids, liquids and gases

The workshop aims to explore with students the different forms matter takes – solid, liquid and gas – and that matter can go through phases and change states.

Key communication messages

A change of state between solid and liquid can be caused by adding or removing heat (energy). Each of these states have different observable properties that can be useful in various situations.

Introduction

Discuss examples of solids, liquids and gases. What makes them solid, liquid or gas?

The presenter will choose volunteers to come out the front and act as particles in a solid, liquid and gas. This will illustrate how heat (energy) changes one state to another, and how we can tell which state something is in.

Presenter demonstration: Film canister rocket.

Activity

Following presenter instructions, students create a “self inflating balloon”:

- Students smell the beaker of clear liquid: what is it? (Vinegar)
- How do we know it is a liquid?
- The powder is Bicarb. Is it a solid or liquid? How do we know?
 - If they are unsure, pour a bit onto the desk and show how it piles up. Water would not do this.
- Experiment steps:
 1. Person A: Practice attaching balloon
 2. Person B: Bicarb into balloon (with funnel)
What do we normally fill balloons with? (gas) What are we filling it with here? (solid)
 3. Person B: Vinegar in conical flask



- 4. Both: Make guess at what will happen
- 5. Person A: attach balloon and leave hanging by side of flask
- 6. Countdown 3, 2, 1 to tip balloon contents into flask
- Discuss observations (bubbles (gas), balloon inflates, strength of balloon, etc)

Following presenter instructions, students create “slime”. Sometimes, an object can be both solid and liquid at the same time! This experiment takes patience and care:

- Pour a tiny drop of water into the cornflower and stir – what changes do you feel? Is it easier or harder to stir?
- Pour another tiny drop of water into the cornflower – how has it changed now?
- Keep going until you get the consistency of slime!

Slime is both solid and liquid – it is a Newtonian Fluid: the more energy you put in, the harder it feels. The solid bits of cornflower hold together. By being gentle, you allow the water to seep around the pieces of cornflower and the slime acts like a liquid.

Conclusion

Presenter demonstration: compression and expansion of air

Notes



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Smooth Moves

the physics of falling: energy and forces.

This workshop is built around open-ended exploratory learning where students create their own solutions to the problems given to them: understanding forces to control the movement of a marble.

Key Communication Messages

The force of gravity can give things energy: whether it is gravitational potential energy, or kinetic energy (when things are falling). We can use this understanding of energy to move a marble down a path as we choose (a "marble run"). Using the force of friction, we can slow a marble's movement, and by increasing its speed, we are also increasing the marble's momentum.

Introduction

Presenter will outlay the materials and equipment for the workshop.

First Challenge: Keep the marble running for 15s without pausing the movement. Think about what forces are helping or hindering this goal.

Break into groups of three.

Activity

As this is an open-ended activity, there is little structure here. The primary task is to encourage students to solve the problems they face on their own, and think outside of the box.

Here are some great prompting questions for students (from *Productive Questions: Tools for Supporting Constructivist Learning* by Mary Lee Marten):

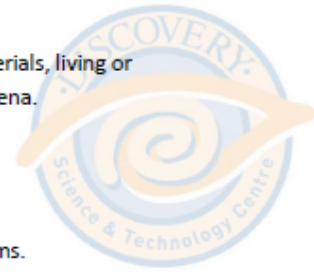
Attention-focusing questions help children fix their attention on significant details.

Have you seen ... ?

What have you noticed about ... ?

What are they doing?

How does it feel/smell/look?



Action questions encourage children to explore the properties of unfamiliar materials, living or nonliving, and of small events taking place or to make predictions about phenomena.

What happens if... ?

What would happen if... ?

What if ... ?

Problem-posing questions help children plan and implement solutions to problems.

Can you find a way to ... ?

Can you figure out how to ... ?

Reasoning questions help children think about experiences and construct ideas that make sense to them.

Why do you think ... ?

What is your reason for ... ?

Can you invent a rule for ...?

These questions are really different from asking children to simply repeat something they have already been told.

Conclusion

Each group discusses their problem solving solutions, and how they would improve their designs, given more time. Each marble run is timed to see which group came closest to the 15 second target!

Notes



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React Now!

Looking at change through chemical reactions

In this workshop, students explore change by creating their own chemical reactions. By observing what happens, students are taking part in the scientific method and discovering that chemistry is just one small branch of science – an umbrella term that contains many different disciplines.

Key communication messages

While everything around us is made up of chemicals, not everything is a chemical reaction.

There are ways we can observe a chemical reaction taking place such as a change in colour, temperature, and the creation of something new.

Introduction

- What are some branches of science?
 - Biology, Physics, astronomy, cosmology, palaeontology, archaeology, geology, geophysics, etc. etc.
 - Definitely something to interest everyone!
- Today is all about Chemistry:
 - *the branch of science concerned with the substances of which matter is composed, the investigation of their properties and reactions, and the use of such reactions to form new substances.*
- We will be looking at three different types of chemical reactions. Important to note that EVERYTHING IS A CHEMICAL. Things can't exist if they are "chemical free". Water's chemical name is Dihydrogen Monoxide (2 hydrogen, 1 Oxygen atom).

Presenter demonstration.

Activity

Following presenter instructions, students create a "cold pack":

- A mixture of sodium bicarbonate and citric acid is mixed in a zip-lock bag.
- Touch the outside of the bag: how does it feel? Is it hot or cold?
- Fill a pipette with water from a beaker. How does the water feel?
- Empty the water into the bag – just enough to wet the powder sufficiently. Watch what happens.



- Touch the outside of the bag again:

What changed? *Temperature.*

Following presenter instructions, students create a “Lava Lamp”:

- Students use their nose to observe what the clear liquid on the table is.
- Get groups to spoon two teaspoons of bicarb into bottom of plastic cup.
- Get groups to put food colouring in the vinegar (2 drops).

Presenter demonstration: densities (physics).

- Now, there is only one beaker of oil. Moving around the table, each group must pour 80ml only on top of the bicarb. Can they work it out?
- Finally, SLOWLY pour vinegar into the oil and bicarb cup. Where does it sit and what is happening?

The change here is that a new chemical has been made...*Carbon Dioxide.*

Students are given time to watch this very pretty experiment. Can they change the colour?

Conclusion

Presenter demonstration: reversible and irreversible change

Notes
