BHP Billiton Science & Engineering Awards

Evaluation Report

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Evaluation Highlights for 2012-15

The BHP Billiton Science and Engineering Awards have been an important part of the Australian Science Awards landscape for over the past 30+ years. The national award is an avenue to encourage students to participate in open inquiry science and engineering related research work.

IMPACT

64% report development of communication skills

86% of teachers report students are extensively impacted by the BHPBSEA

Benefits: increased knowledge & learning, future study & career pathways, networking & making friends

Students expressed an interest in working in the science (86%) and engineering (60%) fields

Open-ended investigations has positive outcomes for students & teachers

56% of teachers are motivated by the benefits the BHPBSEA has for students

BHPBSEA is very important to addressing Australia's STEM issue

LEARNING

Some students struggle with the level of communication required of them

60% report they were not taught at school the skills required to participate in the BHPBSEA

Majority of teachers disagreed that it is always the same or expected types of students who participate

Need to increase awareness of the Awards, especially to new schools

Key marketing messages: freedom to choose and doing an investigation, learn new skills & knowledge, meet like-minded people, work with energetic teachers

Time is the most recognised barrier to teacher involvement

93%

found the internet the most useful resource

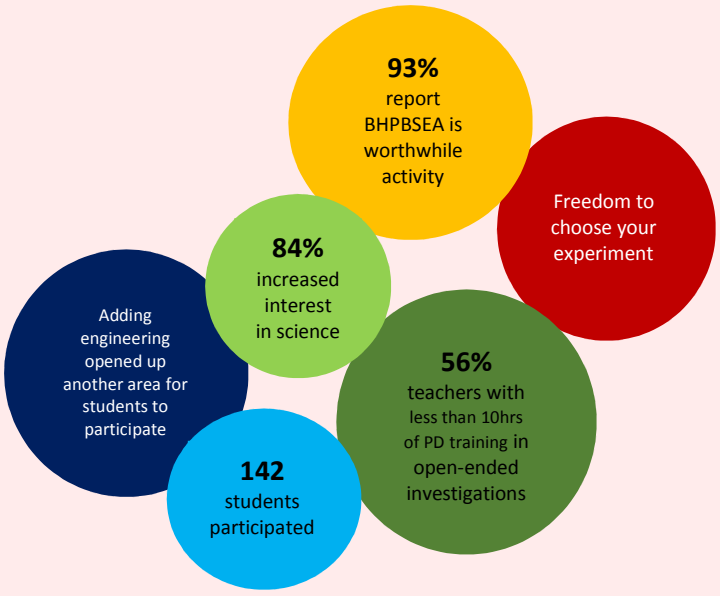
Differences between science curriculums across States affects student and teacher participation

86%

of students see studying science as "cool"

RECOMMENDATIONS

- All participant groups saw a need to increase opportunities to work in teams – suggest a special group award
- Increase opportunities to connect with mentors, particularly past BHPBSEA students / winners and experts / researchers
- Make available more PD opportunities for teachers, but also need to address their "time-poor" factor
- Judges and key stakeholders see initiatives, such as the BHPBSEA, assisting with addressing Australia's STEM issue. It was suggested providers and funders consolidate the number of programs supported



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PART 1: Background and overview of the evaluation

1. Background

1.1 Overview of the BHPBSEA

The BHP Billiton Science and Engineering Awards (BHPBSEA) have been an important part of the Australian Science Awards landscape for over the past 30+ years.

The national award is a high profile event that builds on the research project division of science prizes run in all Australian states, along with the CSIRO CREST program, and is an avenue to encourage students to participate in open inquiry science and engineering related research work and, by virtue of the prize and the individual recognition it affords, build the profile of this sort of high end student research activity in science and engineering in schools.

The stated aims of the BHPBSEA are:

- To improve student communication skills through preparation of reports, posters and dialogue with judges.
- To increase the number of students continuing science at a senior level.
- To improve the view that primary school students have of science.
- To increase the number of students choosing to study science at tertiary level and/or take up careers in science and engineering.
- To increase science teacher professional experience through increasing the amount of inquiry-based science teaching and learning and effective assessment practices in schools.
- To reward outstanding classroom teachers using and, in other ways, supporting open-ended investigations in science classes.

The awards are closely linked with and encourage a range of science research project, engineering competitions and events at state/territory level. The focus of this evaluation is to appraise the effectiveness of the broader setting of the competition in the states/territories in promoting the awards aims, the role played by the BHPBSEA in encouraging and supporting student research projects in Australia and impacting on individuals who enter the awards.

1.2 Evaluation scope

The CSIRO's Performance and Evaluation Team, along with North Partners Pty Ltd, collaboratively collected data and wrote this report reflecting participants' knowledge and perceptions of the impact of the BHPBSEA across the period 2012-15. The findings and recommendations presented in the previous evaluation, conducted by Deakin University in 2009, are provided in Appendix A.

Outline of this evaluation

The scope of this evaluation assesses the BHBPSEA across the following areas:

- Improvements to student skills (e.g. science, engineering, experimental research, and communication).
- Positive changes to student attitudes and perceptions towards science/engineering/technology subjects, experiences with research projects and awards, as well as STEM career aspirations.
- Contributing to the decision making process by students to continue with science at senior secondary and tertiary levels of education.
- Supporting and raising awareness of teacher experiences of open-ended investigations in science classes.
- Contributing to the professional and personal development of those that participate as judges.
- Influencing the development of other State Science Awards and initiatives.

Methods

A mix methods design was used to collect all data (see Table 1 for details). This involved online surveys, interviews, secondary data and an online media analysis.

Evaluation questions explored the participants' experience in regards to science and engineering research investigations, as well as the perceptions of the benefits, challenges and long and short term impact of the BHPBSEA initiative.

Data was gathered across Australia, with student interviews limited to two states with different characteristics: Queensland and the Australian Capital Territory.

Table 1 Overview of methodology

Participating group	Method	Knowledge & perceptions of:
All students who were involved in the BHPBSEA competition over the last three years Student finalists from the last two years	Online survey Semi-structured interview Request Secondary data in regards to enrolment	• Engagement of students with science • Investigative skills and appreciation of the nature of science • Views of school science and science more generally • Career intentions in relation to science • Awareness of BHPBSEA • Communication skills • Engagement of students with science • Investigative skills and appreciation of the nature of science • Views of school science and science more generally • Career intentions in relation to science • Awareness of BHPBSEA
Teachers involved in science competitions who had students enter the BHPBSEA Prize winning teachers	Online survey Semi-structured interview Request Secondary data in regards to enrolments	• Engagement of students with science • Investigative skills and appreciation of the nature of science • Views of school science and science more generally • Enrolment patterns in school science • Numbers of students enrolling in science related tertiary courses • Awareness of BHPBSEA • Teacher pedagogy and assessment practices • Attitudes towards open ended science investigations • Worthwhileness of science research investigation initiatives
State science association and CREST representatives	Online survey Semi-structured interview	• Attitudes towards open ended science investigations • Worthwhileness of science research investigation initiatives
Judges from 2012 - 2015	Online survey Semi-structured interview	• Communication skills • Investigative skills and appreciation of the nature of science
Key players in the award system (CSIRO, CREST, ASTA)	Online survey Semi-structured interview	• Worthwhileness of science research investigation initiatives

Online survey and semi-structured questions

Survey and interview questions (see Appendices B, C, D and E for the list of all questions) were asked to each of the following stakeholders:

- All students who were involved in the BHPBSEA competition over the last three years
- Teachers involved in science competitions who had students enter the BHPBSEA, as well as prize winning teachers
- State science association and CREST representatives
- Judges from 2012 – 2015
- Key players in the award system (CSIRO, CREST, ASTA)

The online survey was administered using the platform SurveyMonkey, while the interviews were conducted by phone, using audio recording. Transcribing of all interview responses was undertaken in order to assure accurate collection of responses, for use in reliability processes, and record keeping.

Secondary data sources

Gathering of hard data that is convincing and takes into account the many variables that would impact on science courses and career choices would be a major undertaking in its own right. To pursue this question, CSIRO and North Partners would expect to gain anecdotal evidence through questioning of student aspirations, retrospective accounts of entrants who are now in tertiary

education and of teacher experience of trends within their school. The findings will be indicative, and the argument circumstantial. Interview participants will be asked to provide any evidence that could confirm course and career choices but this will be voluntary and at the discretion of each individual.

Media analysis

The aim of this method is to analyse collected online media mentioning the BHPBSEA. Data was sourced from an archive of online media gathered by SIRO Education staff, limited to the 2014 period. To view the detailed coding criteria, see Appendix F.

Sample

Participants for the evaluation consisted of:

- Students involved in research competitions,
- Students who have reached the final of the awards,
- Teachers involved in running research project competitions as well as prize winning teachers,
- Judges,
- Science coordinators who might be able to throw some light on enrolment trends, and
- State organisers of these competitions including the BHP Billiton organisers.

Table 2 below provides a comparison of samples between the previous and current evaluations. The evaluation collected survey data from all stakeholders, as opposed to only students in the 2009 report. This provided an opportunity to collect feedback from a wide variety of participants.

Table 2 Comparative evaluation samples

Participant Group	Method	2009 Evaluation	Current Evaluation	
		Sample size	Sample size	Response rate
Students	Online Survey	65	142	34.5%
	Semi-Structured Interviews	3	6	-
Teachers	Online Survey	-	10	40%
	Semi-Structured Interviews	17	2	-
Judges	Online Survey	-	13	44.8%
	Semi-Structured Interviews	5	1	-
Other Key Stakeholders	Online Survey	-	9	81.8%
	Semi-Structured Interviews	5	1	-
TOTAL		**95**	**Survey: n=174 Interview: n=10**	**-**

The tables below (3, 4, 5, & 6) provide an overview of the participants' demographics for each stakeholder group.

Students

Table 3. Student participant demographics

Demographic	Details	No. of Responses	Response Percentage
Gender	Female	142	50.4%
	Male		49.6%
Age	Under 10 years	115	7%
	10-15 years		34.8%
	16-20 years		53%
	21-25 years		0.9%
	26-30 years		0%
	31-35 years		0%
	36-40 years		0%
	Over 40 years		4.3%
Current school level	Primary	115	20%
	Secondary		54%
	Tertiary		21.7%
	Other		4.3%
State	Australian Capital Territory	115	10.4%
	New South Wales		20.9%
	Victoria		15.7%
	Queensland		23.5%
	Northern Territory		0.9%
	South Australia		13.0%
	Western Australia		7.8%
	Tasmania		7.8%
Number of times participated in the BHPBSEA	1	107	73.8%
	2		20.6%
	3+		5.6%
What year(s) did you participate in the BHPBSEA	2013	105	27.6%
	2014		50.5%
	2015		28.6%
	Previous years		18.1%
Were you a BHPBSEA finalist?	Yes	105	68.6%
	No		31.4%
Did you participate as an individual or a member of a group in the BHPBSEA?	Individual	105	90.5%
	Group Member		9.5%
Who nominated you for the BHPBSEA?	Self-submission	105	5.7%
	My school Teacher		48.6%
	Your State Teacher Association		29.5%
	Other		16.2%
Which type of BHPBSEA were you nominated?	Science Award	105	82.9%
	Engineering Award		17.1%

Teachers

Table 4. Teacher participant demographics

Demographic	Details	No. of Responses	Response Percentage
Gender	Female	9	55.6%
	Male		44.4%
Age	Under 10 years	10	0%
	10-15 years		0%
	16-20 years		0%
	21-25 years		10%
	26-30 years		10%
	31-35 years		10%
	36-40 years		10%
	Over 40 years		60%
How long have you been a teacher?	Less than 1 year	10	0%
	1 - 3 years		0%
	4 - 6 years		20%
	7 - 10 years		30%
	11 - 15 years		10%
	16 - 20 years		0%
	More than 20 years		40%
State	Australian Capital Territory	10	20.0%
	New South Wales		10.0%
	Victoria		10.0%
	Queensland		20.0%
	Northern Territory		0.0%
	South Australia		10.0%
	Western Australia		10.0%
	Tasmania		20.0%
What year(s) did you participate in the BHPBSEA	2013	10	40%
	2014		60%
	2015		70%
	Previous years		30%
Did you receive a BHPBSEA teacher award?	Yes	10	90%
	No		10%
Who nominated you for the BHPBSEA teacher award?	Self-submission	10	0%
	My school Principle		10%
	Your State Teacher Association		70%
	Other		20%

Judges

Table 5. Judge participant demographics

Demographic	Details	No. of Responses	Response Percentage
Gender	Female	13	45.5%
	Male		54.5%
Age	Under 10 years	13	0%
	10-15 years		0%
	16-20 years		0%
	21-25 years		0%
	26-30 years		0%
	31-35 years		7.7%
	36-40 years		23.1%
	Over 40 years		69.2%
State	Australian Capital Territory	11	18.2%
	New South Wales		0.0%
	Victoria		54.5%
	Queensland		9.1%
	Northern Territory		0.0%
	South Australia		0.0%
	Western Australia		9.1%
	Tasmania		9.1%
What year(s) did you participate in the BHPBSEA?	2013	11	36.4%
	2014		36.4%
	2015		54.5%
	Previous years		45.5%
Which areas were you a judge?	Teacher awards	13	0%
	Student awards		76.9%
	Both		23.1%

Key Stakeholders

Table 6. Key stakeholder participant demographics

Demographic	Details	No. of Responses	Response Percentage
Gender	Female	8	75.0%
	Male		25.0%
Age	Under 10 years	8	0%
	10-15 years		0%
	16-20 years		12.5%
	21-25 years		0%
	26-30 years		0%
	31-35 years		0%
	36-40 years		12.5%
	Over 40 years		75%
State	Australian Capital Territory	8	25.0%
	New South Wales		12.5%
	Victoria		12.5%
	Queensland		12.5%
	Northern Territory		0.0%
	South Australia		0.0%
	Western Australia		25.0%
	Tasmania		12.5%
What year(s) did you participate in the BHPBSEA?	2013	8	50.0%
	2014		75.0%
	2015		62.5%
	Previous years		62.5%

Limitations

The only limitation to note is the lack of secondary data provided by participants. Although participants were requested to provide any evidence they had in regards to enrolment, no such documents were submitted to the evaluation team. Therefore, the assumption of self-reported behaviours is taken as reflective of actual behaviour.

PART 2: Evaluation findings

2. Ability to develop student interests and skills

The focus of this section is to provide reflections, across all stakeholder participants, on the BHBPSEA's ability to influence or change student interests and skills in science, engineering, experimental research and communication.

2.1 Interest in science, engineering and technology

Students were asked about their level of interest in science, engineering and technology BEFORE and AFTER participating in the BHPBSEA (see Table 7 and Figure 1 below). Overall, there was a positive shift in the level of interest students had across the three topic areas. Both science (2%) and technology (5%) had minor changes, while those interested and very interested in engineering (9%) significantly increased after being involved in the BHPBSEA.

Table 7. Student interest in science, engineering and technology: Before and after BHPBSEA

	Science		Engineering		Technology	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
very boring	0%	0%	1%	1%	1%	1%
boring	1%	0%	3%	5%	3%	3%
neutral/unsure	6%	5%	31%	20%	22%	17%
interesting	32%	23%	34%	29%	33%	30%
very interesting	61%	72%	31%	45%	41%	49%

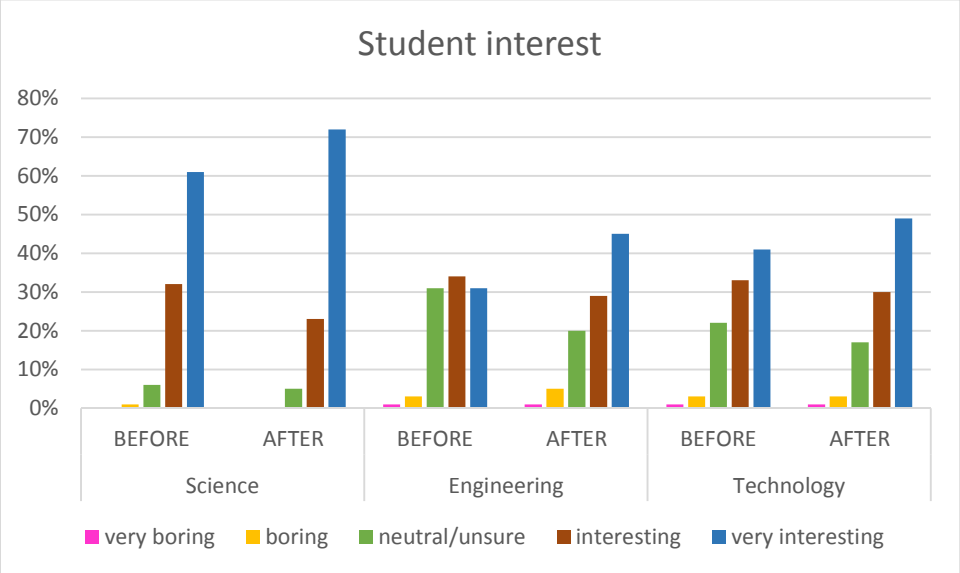

Figure 1. Comparing student interest in science, engineering and technology: Before and after BHPBSEA

The results provided above were also supported by other survey questions, specifically relating to student interest in science and engineering (Table 8). An overwhelming majority of participants (84%) agreed and strongly agreed that the BHPBSEA increased their interest in science. Yet, the responses related to increasing interest in engineering was slightly less than the majority (43% agreed or strongly agreed). Only 9% of participants disagreed or strongly disagreed that the BHPBSEA raised their interest in science, compared to 19% for engineering. The results could be influenced by the majority of survey participants involved in competing for a science award (83%) and not an engineering award (17%).

Table 8. Increasing student interests in science and engineering

On a scale of 1 (strongly disagree) to 5 (strongly agree), how much do you agree with the following statements?						
	strongly disagree	disagree	unsure/neutral	agree	strongly agree	N/A
Participating in the BHPBSEA increased my interest in science	2%	7%	6%	53%	31%	1%
Participating in the BHPBSEA increased my interest in engineering	3%	16%	31%	22%	21%	7%

2.2 Communication skills

Students were asked if the BHPBSEA helped with the development of their communication skills. The majority (64%) responded 'yes', 16% responded 'no', and 20% 'unsure'. Forty-six participants provided an explanation to their answers, 80% were positive, 17% were negative and 2% were neither positive nor negative.

Positive Responses

Students who responded positively identified some key areas in which they feel their communication skills had been improved through their involvement in the BHPBSEA. These categories include: report writing (36%), confidence in speaking about science (24%), general oral skills (22%), communicating with others (9%) and scientific terminology (9%).

One student commented on how the BHPBSEA helped their communication skills in a variety of ways by stating, *"The interview, and presenting my research countless times to a variety of people greatly helped improve my communication skills. I could feel the difference in my skills, attitude and confidence between the first day I got to the 'camp' and the day I left."*

Negative Responses

The dominant reason some students felt that their communication skills were not improved was that they felt that their communication skills were adequate before their participation in the BHPBSEA (38%), with one student stating, *"I have always had very strong communicative skills, hence my strongest subject is English. Because of this, I do not feel the awards helped in any way."*

Other responses suggested their communication skills were not improved due to: working individually and not in a group (25%), still feeling a need to improve their communication skills (13%), their struggle with the level of communication required of them throughout the BHPBSEA (13%) and a further 13% did not provide a specific reason.

2.3 Most useful resources

Participants found the internet (93%), parents/guardians (65%), books (63%) and teachers (60%) the most useful resources in completing their investigations. Yet for some students, the least helpful resources were other students (23%), teachers (19%) and parents/guardians (18%), with 49% of participants not using mentors or other students (47%) as possible avenues for help (Table 9).

In addition, 13 students identified resources using the 'other (please specify)' category. These were listed as:

- Store/company aided them in gaining resources or information (27%),
- Experts or researchers in the field assisted them (27%),
- A family member (9%),
- A lab technicians (9%),
- A past entrant (9%),
- Community members (9%), and
- Friends (9%).

Table 9. Most useful resources

On a scale of 1 (not helpful) to 5 (very helpful), which resources did you use, and how helpful were they?						
	not helpful	a little helpful	neutral/unsure	helpful	very helpful	Did not use
Internet	0%	4%	1%	25%	68%	2%
Books	2%	12%	9%	48%	15%	14%
Teacher	6%	13%	13%	24%	36%	8%
Parent/Guardian	5%	13%	9%	36%	29%	8%
Mentor	7%	6%	10%	10%	18%	49%
Other students	14%	9%	13%	15%	2%	47%

2.4 Overall science capabilities and academic results

Students were questioned in regards to the links between the BHPBSEA experiences and their classroom content, skill development and academic achievement (see Table 10).

The majority of participants (54%) agreed and strongly agreed that they were provided with opportunities to design and carry out investigations, similar to the BHPBSEA, in their normal classroom activities. Yet, over a quarter of participants (26%) were not exposed to this kind of activity at school. Only 38% of participants agreed or strongly agreed that they possessed all the required skills to complete an investigation for the BHPBSEA, which they learnt at school. The mainstream response (60%) reflected that participants were either unsure or definitely were not taught the skills required to participate in the BHPBSEA from the current curriculum provided in their classrooms.

Finally, 51% of participants agreed or strongly agreed that the BHPBSEA helped them to achieve better academic results in science. A fifth of respondents (21%) would not attribute the BHPBSEA to their academic performance at school and 22% unsure of the correlational link.

Table 10. BHPBSEA contributing to skills development and academic results

On a scale of 1 (strongly disagree) to 5 (strongly agree), how much do you agree with the following statements?	strongly disagree	disagree	unsure/neutral	agree	strongly agree	N/A
In my normal science class I complete in activities similar to the BHPBSEA, where I get to design and carry out my own investigation	11%	15%	15%	29%	25%	5%
All the skills I needed to complete the BHPBSEA investigation were learnt in my normal science classes at school	15%	24%	21%	23%	15%	2%
Participating in the BHPBSEA helped me obtain better marks for my science subjects at school	1%	20%	22%	31%	20%	6%

3. Student awareness, attitudes, perceptions and career aspirations

This section reports on student awareness of the BHPBSEA Awards, experiences with research projects and awards, attitudes and perceptions towards science and engineering subjects, as well as STEM career aspirations.

3.1 Awareness of the BHPBSEA Awards

This question was posed to both students and teachers who have participated in the BHPBSEA. Eight students and eight teachers responded to this question with no one answering in the 'very low' category. Thirty-eight per cent of both teachers and students suggested that awareness was 'low' with a further 25% of both teachers and students were 'neutral'. Twenty-five per cent of teachers and 38% of students suggested that awareness was 'high' with one teacher stating that they felt awareness was ‘very high’.

The differences between teacher and students responses could be attributed to variations between schools and access to promotional and awareness material for the BHPBSEA.

In addition, judges also reflected on their interaction with students and their opinion of the awareness of the BHPBSEA. Generally, their impression of participating students was one of genuine excitement about their experiences with the process. Over 28% stated that they believe that some students were aware of the Awards yet a majority of the general student population would be unaware.

3.2 What motivates the students to enter science and research competitions?

The key areas of motivation for students, as outlined by teacher participants, included: winning and prizes (22%), with one teacher reflecting, *"Winning is also what competitions are about and having a worthwhile prize as an incentive cannot be overlooked"*, and teachers (22%), with one teacher stating it was motivational to students to have, *"enthusiastic teachers who promote the competition to their student and encourage them to participate"*.

Other responses included: a topic of personal interest to the student (17%), recognition of hard work (17%), the experience of the competition (11%), improved marks/grades (6%) and support in the form of time, materials and parental involvement (6%).

3.3 Experiences with research projects and awards

Teachers and key stakeholders were asked a series of questions in regards to student experiences with research projects and general science competitions and awards. A summary of their responses are provided below.

What sort of students have enjoyed participating in these competitions?

The teachers who responded to this question explained a variety of student types that have enjoyed participating in science research competitions. Some teachers (15%) outlined that all students were given the opportunity to participate and 15% stated that, in their experience, students who were interested in science seemed to enjoy it most, with one teacher responding that, *"A range of students with varying abilities but all are interested in science"*.

The teacher participants outlined some characteristics that students who enjoy the competitions might exhibit including: persistence (15%), determined (15%), curious (8%), well supported (8%),

proficient with technology (8%) good communication skills (8%) and students who are in middle school, years 5 - 7 (8%).

Is it always the same ones [students] who enjoy science classes?

Of the teachers who responded to this question, 38% stated that is was always the students who enjoyed science class and participating in science research competitions. Yet, 50% disagreed, stating it wasn't always the same or expected type of student, and 13% were unsure.

To what extent does participation in science and engineering competitions impact on students?

The teachers who responded to this all expressed their belief that science and engineering competitions do impact students within either the 'somewhat' category or the 'extensive' range when it came to investigative skills, appreciation of the nature of science, communication skills, engagement with science and views of school science and science more generally. Eighty-six per cent of teachers stated that students were ‘extensively’ impacted in regards to investigative skills, appreciation of the nature of science and communication skills and 57% of teachers responded that students were ‘extensively’ impacted when it came to their engagement with science and their views of school science and science more generally.

Judges also provided their opinions on the extent to which science and engineering investigation initiatives provided positive experiences students and assisted with skill development (see Table 11). All the judges hold the opinion that investigation initiatives in general motivate and increase the enjoyment of science, develops skills such as problem-solving, technical processes and conceptualisation, as well as assisting with the development of positive attitudes towards themselves (self-esteem) and sense of achievement.

Table 11. Positive experiences and skills development from investigation initiatives

Please rate, on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which you agree that science and engineering investigation initiatives providing students with the following:	strongly disagree	disagree	neutral/unsure	agree	strongly agree
Motivation and enjoyment of science	0%	0%	0%	63%	37%
Developing positive attitudes towards themselves	0%	0%	0%	50%	50%
Stimulating curiosity and creativity	0%	0%	0%	25%	75%
Conceptual development	0%	0%	0%	37%	63%
Developing investigation and problem-solving skills	0%	0%	0%	25%	75%
Developing techniques and manipulative skills associated with using scientific or technical equipment	0%	0%	0%	37%	63%
Providing concrete experiences of a scientist or engineer	0%	0%	0%	25%	75%
Developing positive attitudes towards learning as a lifelong process	0%	0%	0%	50%	50%
Experiencing and developing an understanding of the nature and practice of science or engineering	0%	0%	0%	37%	63%
Learning to work autonomously	0%	0%	0%	25%	75%
Learning to work cooperatively	0%	0%	13%	25%	63%
Language development	0%	0%	13%	37%	50%
Developing positive attitudes towards and science and technology	0%	0%	0%	25%	75%

What aspects of the participation most significantly impacted on the students?

Eighty-six per cent of the teachers who responded to this question stated that 'doing the research project itself' had an 'extensive' impact on students and 86% of teachers believe that completing the reporting section of the project had somewhat of an impact on students. When it comes to the impact participating in an across-school competition had on students, 14% of teachers said it had 'little impact', 71% said it had 'somewhat' of an impact and 14% stated it had an 'extensive impact'.

When asked about the impact on students of achieving success in the competition, 12% were 'unsure', with a significant number of participants (88%) suggesting there was 'somewhat' or an 'extensive impact'.

When it comes to students participating in the BHP Billiton camp, 14% said there was 'no impact' to students, 29% stated they were 'unsure' or that there was a 'neutral' impact and 57% responding there was an 'extensive impact'.

3.4 Is the BHPBSEA a worthwhile activity?

A significant majority (93%) of student participants agree and strongly agree that the BHPBSEA is a worthwhile activity to be involved with (Figure 2). In addition, the majority of judges (50%) stated that they believe that students felt supported and competitions were valued, with one judge stating, *"Most of the top students have come from schools that encourage participation in competitions and awards".*

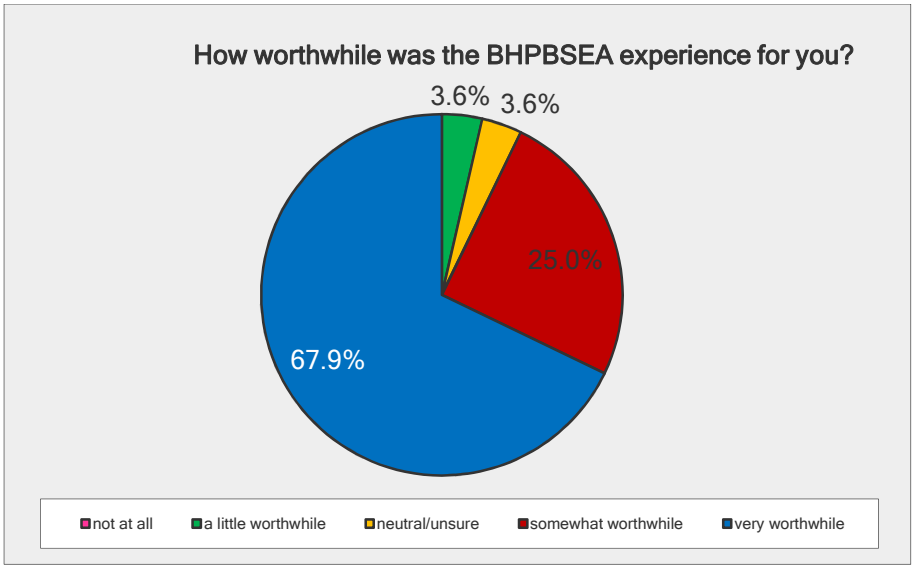

Figure 2. Students view BHPBSEA as a highly worthwhile activity

Below is a summary of the benefits reported from participating in the BHPBSEA

Students

The students were very forthcoming with sharing what they feel benefitted them from participating in the BHPBSEA, highlighting multiple benefits they have experienced. A list of the top three benefits is summarised below:

1. Increased knowledge and learning (15%),
2. Future study and career pathways, with one student explaining the awards, were *"fostering an increased interest in science and engineering and developing future connections and pathways"* (13%),
3. Networking or making friends with people who share similar interests with one student stating, *"The BHPBSEA provides an opportunity for those with an idea to try and take it to the*

next level, get it known by more people and to meet like-minded people of a similar age" (12%).

Other benefits mentioned by students included: gaining recognition (8%), increased interest in science (8%), the opportunity to share ideas (7%), real-life application of science and engineering (6%), communication skills (5%), increased confidence (5%), sense of achievement (4%), being inspired (4%), sense of pride (3%), problem solving skills (2%), challenging themselves (2%), winning prizes (2%), improved group working skills (2%), report writing (2%), independent learning (2%) and improved research skills (1%).

In addition, the students that participated in the survey also reflected on the best things about the BHPBSEA (see Table 12). The most significant elements were the 'freedom to choose the experiment' (81%) and the actual 'doing the experiment/investigation' (79%). The majority found 'learning new skills' (67%) important as well. 'Working in a group' (10%) was seen to be the least important aspect of the process.

Nineteen students identified 'something else' that they saw as the best thing about the BHPBSEA. These included: investigating a topic of interest or importance (26%), meeting like-minded people (23%), learning/ gaining knowledge (17%), increased confidence (13%), completing the investigation (9%), the combination of science and engineering (4%), having autonomy (4%) and preparing for further education (4%).

Table 12. Best things about the BHPBSEA

What was the best thing about the BHPBSEA? (you can tick multiple boxes)	
	Response Percent
Freedom to choose the experiment	81%
Receiving the certificate	44%
Doing the experiment/investigation	79%
Learning new skills	67%
Working in a group	10%
Working on my own	41%
Something else	13%

Teachers

Teacher participants also reflected upon what they saw as the outcomes for students in participating in science research competitions. The teachers who responded to this question were resoundingly positive. Outlined as the three most prominent outcomes were:

1. Improved scientific knowledge and ability (15%),
2. Student recognition (15%), and
3. Improved investigative skills (15%), with one teacher stating that the competitions gave the students the opportunity to *"learn and practice good investigative skills ... design of experiment - understanding variables/controls, mathematical modelling, data gathering and analysis and communication".*

These were followed by: networking opportunities (10%), engagement in science (10%), improved maths skills (10%), increased confidence (5%), improved time management skills (5%), improved resilience (5%), increased curiosity for science (5%) and improved communication skills (5%).

Judges

Judges also reflected upon their opinions in regards to the benefits experienced by students. Four key themes were identified from the judges' responses, these were: future study/ career prospects (20%), prizes (10%), the camp (10%) and being motivated by their participation (10%).

3.5 Attitudes and perceptions towards science and engineering subjects

Not surprisingly, the majority of participants see themselves as being good at science (91%) as well as enjoy (87%) and looking forward to (93%) their science classes at school (Table 13). They have also have a history in being interested in science (87%) or engineering (50%) and view studying science as "cool" (86%). In addition, the student participants view science as among the most interesting things they do in school (68%) and believe more time should be spent on science each week (54%).

Participants also reflected a strong view that science (100%) and engineering (89%) knowledge is useful to everyday life, and will benefit an individual when going for a job (science, 79%; engineering, 74%). Finally, 86% of participants expressed an interest in working in the science field, with 60% keen to work in the engineering field.

Table 13. Attitudes and perceptions of science and engineering subjects

On a scale of 1 (strongly disagree) to 5 (strongly agree), how much do you agree with the following statements?						
	strongly disagree	disagree	unsure/neutral	agree	strongly agree	N/A
I look forward to science lessons	0%	1%	5%	44%	49%	1%
I enjoy the activities we do in science	0%	2%	11%	52%	35%	0%
What we do in science are among the most interesting things we do in school	0%	5%	26%	42%	26%	1%
We should spend more time on science each week	1%	9%	34%	28%	26%	2%
Science is useful in everyday life	0%	0%	0%	42%	58%	0%
Engineering is useful in everyday life	0%	3%	8%	45%	44%	0%
I am good at science	0%	0%	7%	39%	52%	2%
Knowing science helps get a job	0%	0%	19%	38%	41%	2%
Knowing about engineering helps to get a job	0%	2%	20%	43%	31%	4%
Studying hard in science is not cool to do	57%	29%	8%	4%	1%	1%
I have always been interested in science	0%	4%	9%	37%	50%	0%

I have always been interested in engineering	6%	16%	27%	31%	19%	1%
I would be interested in working in a science related field	0%	6%	7%	29%	57%	1%
I would be interested in working in an engineering related field	7%	14%	17%	23%	37%	2%

Students were asked about their willingness to learning more about science or engineering from doing the investigation and being a participant in the BHPBSEA scheme. Ninety per cent indicted 'yes', with 5% answering 'no' and 5% 'unsure'. Forty-two students provided more detail to their answer.

Positive responses

Students who responded positively to this question highlighted some key areas or learning.

> 35% indicated that they had learned topic-related knowledge, as one student explained, *"This strengthened my understanding of the Heisenberg Uncertainty Principle (which I had previously heard of), thus allowing me to continue exploring quantum and particle physics".*
>
> 14% stated they had learned about the scientific process, as suggested by this student, *"The investigation I entered was the first I had done so I learnt a lot about scientific processes and the evaluation of data"*.
>
> Some students (10%) also indicated that they had learnt a lot from other submissions/investigations, as one student explained, *"I learnt more about different aspects in both science and engineering from other people's experiments/tests".*

Other responses included:

- How to convey ideas to others/communication (6%),
- Problem solving skills (6%),
- Other aspects of science/engineering (6%),
- Potential carer pathways (4%),
- A deeper appreciation of science/ engineering (4%),
- Understanding and experience with the real-world application of science/ engineering (4%),
- New technologies (2%),
- The value of hard work (2%),
- Being thorough (2%),
- Finding a gap in current research (2%),
- Patience (2%),
- Combining science and engineering (2%), and
- Goal-driven approach (2%).

Negative Responses

Only one comment was provided in regards to not learning anything new about science and engineering through participation in BHPBSEA - *"I am home schooled and do open-ended investigations anyway"*.

3.6 Interest in a STEM career

Participants were asked to reflect upon their level of interest in a career in science, engineering or technology, BEFORE and AFTER being involved in the BHPBSEA (Table 14 and Figure 3). Overall, there was a positive trend for all career areas, with an increase of those interested or very interested in a science (11%), engineering (10%) or technology (14%) career after involvement in the BHPBSEA.

Table 14. Level of interest in a STEM career: Before and after BHPBSEA

	Science		Engineering		Technology	
	BEFORE	AFTER	BEFORE	AFTER	BEFORE	AFTER
not interested	1%	0%	14%	11%	13%	9%
a little interested	5%	6%	5%	10%	9%	8%
neutral/unsure	17%	6%	28%	16%	27%	18%
interested	27%	30%	30%	27%	25%	33%
very interested	50%	58%	23%	36%	26%	32%

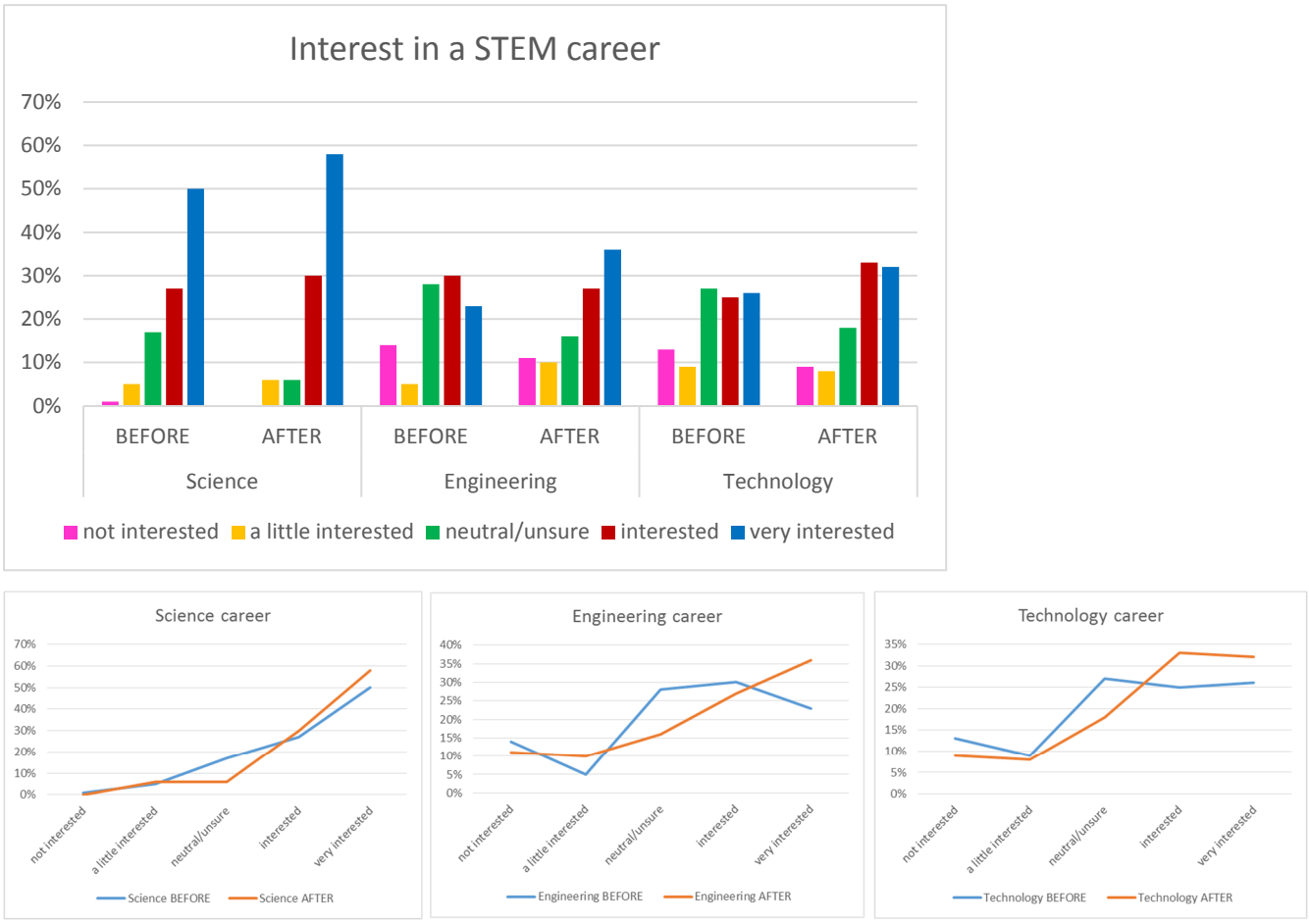

Figure 3. Interest in a STEM career: Before and after BHPBSEA

Did your involvement in the BHPBSEA inspire you to do more in the area of science or engineering?

Students were asked if they were inspired by the BHPBSEA experience. A majority (60%) stated 'yes', 18% said 'no' and 22% were 'unsure'. Forty-five students elaborated on their response of 'yes' or 'no', with the vast majority being positive. A summary of these responses are provided below:

> 28% of students have stated that thanks to their participation in the BHPBSEA they have decided to pursue a career in science or engineering, as one student acknowledged, *"Participating in the BHPBSEA really enhanced my appreciation of the huge positive impact a career in science can have on others' lives. I am now pursuing that career in science by studying medicine".*
>
> 23% of students stated that they are already pursuing a career in science or engineering and 21% of students revealed that they wanted to follow a science or engineering pathway before participating the BHPBSEA and this has not changed as one student commented, *"I am now interested in being an engineer like my brother, I never considered this before."*

Other responses included: students now wanting to explore a different area of science or engineering (10%), students who are not interested in pursuing science or engineering, but may consider it as a 'plan B' (8%), students who were interested in pursuing science and engineering pathways but have since changed their minds (5%), students who are more knowledgeable about pathways thanks to the BHPBSEA (3%) and students who chose senior subjects to allow for a science or engineering pathway (3%).

4. Choosing science subjects

This section provides an overview of the contribution BHBPSEA made on the decision making process of students to continue with science at senior secondary and tertiary levels of education.

A significant majority of student survey participants indicated that they expected to enrol in science or engineering courses in secondary school (87%), with 68% reporting intent to enrol in science (68%) at university but only 38% in engineering. Once again, this could be reflective of the larger number of participants identifying as science only award participants, as opposed to involvement as an engineering competitor. In addition, participants attribute their involvement in the BHPBSEA to their enrolment decision at the secondary (49%) and university (56%) levels.

In regards to the BHPBSEA's influence on student attitudes towards science and engineering, 64% of participants acknowledged the experience had on their positive outlook for these fields and 49% indicating that their participation has now shifted the way they think about science and engineering. Although, 50% of participants reflected that they would have felt the same way about the fields even if they did not have involvement in the BHPBSEA (see Table 15). This finding is in alignment to the attitudinal data presented in the previous section, which captured the positive, enthusiastic and willingness to engage and learn about both science and engineering subjects.

Table 15. Enrolment behaviour

On a scale of 1 (strongly disagree) to 5 (strongly agree), how much do you agree with the following statements?						
	strongly disagree	disagree	unsure/neutral	agree	strongly agree	N/A
I will choose some science or engineering subjects in Years 11 and 12	0%	1%	2%	13%	74%	10%
Involvement in the BHP Billiton Awards contributed to your choice on high school science enrolment.	6%	12%	21%	25%	24%	12%
I will enrol in science at university	1%	5%	22%	32%	36%	4%
I will enrol in engineering at university	8%	15%	32%	18%	20%	7%
The Award scheme experience has influenced your thoughts about enrolling in science or engineering at university	5%	13%	25%	32%	24%	1%
The Award scheme influenced your attitude towards science or engineering	4%	15%	17%	35%	29%	0%
I think of science or engineering differently because of the Award scheme	6%	18%	26%	29%	20%	1%
I would feel the same about science or engineering if I had not got an award	5%	22%	21%	26%	24%	2%

Teacher reflections on enrolment behaviours

Teachers responded to this question, with 71% stating that they were 'unsure' of enrolment patterns and data with one teacher saying, *"I have very little evidence relating to this. Only observed effects on a few individuals: our 2015 finalist chose 2 sciences in Y11 instead of 1".* The other 29% stated that there may have been an increase in student enrolment in science subjects with one teacher adding,

> *"We have observed that enthusiasm, participation and enrolment in senior secondary science classes has increased at our school over the last 5 years since our involvement in such competitions has widened to include all students and not just a select group. Anecdotally we have seen increased interest in the Sciences and factual data has shown improving enrolment in senior secondary science subjects and students undertaking science based post-secondary study".*

5. Open-ended investigations

The aim of this section is to provide a summary of student and teacher experiences with open-ended investigations.

5.1 Australian curriculum in general

Eighty-six per cent of teachers agreed that the science research competitions relate to the school's science curriculum, as one teacher states, *"Some topics link directly into the content. All projects meet the "Science Inquiry" and "Science as a Human Endeavour" strands"*, while 14% responded that the science research competitions do not relate to the school's science curriculum. This response was influenced by the state in which the participating teacher was located. Consistency in science curriculum could address the alignment between the aims of science and engineering initiatives and what is taught in classrooms.

5.2 Experiences of and opinions on open-ended investigations

Overall, the majority of students viewed the open-ended investigation approach as an opportunity to pursue their topic of interest (63%). The approach was seen to support the chance to go beyond regular exercises set in the classroom (48%) and do experiments that were different to everyone else (51%). Yet, 37% of the student participants reflected the inability to be flexible beyond the regular classroom laboratory exercises. It appears that once a topic is chosen (whether independently or directed), the design (60%) and best way to carry out the experiment (51%) is heavily influenced by the student's teacher (see Table 16).

Table 16. Student reflections on using an open-ended investigation approach

On a scale of 1 (never) to 5 (always), using the open ended investigation approach, how often would you have:					
	never	a little	neutral/unsure	sometimes	always
An opportunity to pursue your own science or engineering interest	3%	18%	16%	55%	8%
Be made to design your own experiments to solve a problem given by the teacher	11%	18%	11%	48%	12%
See other students collect data for the same problem	8%	17%	24%	37%	14%
Be allowed to go beyond the regular laboratory exercises and do some experimenting of your own	12%	25%	15%	37%	11%
Do different experiments to other students	12%	21%	16%	38%	13%
The teacher decides the best way for you to carry out the experiment	6%	18%	25%	33%	18%

Teachers were also asked about their opinions and use of open-ended investigations. Below is a summary of their responses.

Own and other teachers' attitude towards open-ended science investigations

Over 57% of teachers responded that their whole school used open-ended science investigations, with the remaining 42% stating 'no' to a whole school application of the method.

Twenty-nine per cent of teachers stated that their own and other teachers' attitudes towards open-ended science investigations had been significantly impacted by their involvement in student research competitions and 71% reported that there was a very significant impact.

In addition, both teachers and key stakeholders agree and strongly agree that across multiple aspects relating to the open-ended investigation approach, the method has positive outcomes for students and teachers (see Tables 17 and 18).

Table 17. Positive effects of open-ended investigations: Teacher responses

Please rate, on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which you agree with the following statements about open-ended science investigations:					
	strongly disagree	disagree	neutral/unsure	agree	strongly agree
Is a good source of activities	0%	0%	0%	71%	29%
Gets boring after a few years	71%	29%	0%	0%	0%
Increased my confidence to teach science	0%	0%	14%	14%	71%
Promotes skill and concept development across the whole class	0%	0%	0%	14%	86%
Helped me to learn science	0%	0%	29%	43%	29%
Kids love it	0%	0%	0%	43%	57%
Requires a lot of time for collecting information and resources	0%	14%	0%	43%	43%
Does not meet the requirements of the syllabus	57%	43%	0%	0%	0%
Is too difficult for poor readers	29%	57%	0%	14%	0%
Provides a common language for communication about science	0	0%	0%	57%	43%
Is a good approach for a teacher who lacks experience in science	0%	43%	14%	43%	0%
Makes assessment difficult	29%	43%	14%	14%	0%
Professional development opportunities are inadequate	14%	14%	29%	29%	14%

Table 18. Positive effects of open-ended investigations: Key Stakeholder responses

Please rate, on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which you agree with the following statements about open-ended science investigations:					
	strongly disagree	disagree	neutral/unsure	agree	strongly agree
Is a good source of activities	0%	0%	13%	37%	50%
Gets boring after a few years	62%	13%	13%	0%	13%
Increases teacher confidence to teach science	0%	0%	25%	50%	25%
Promotes skill and concept development	0%	0%	0%	37%	63%
Helps teachers to learn science	0%	0%	13%	50%	37%
Students love it	0%	0%	0%	63%	37%
Requires a lot of time for collecting information and resources	0%	0%	0%	75%	25%
Does not meet the requirements of the Australian curriculum	75%	25%	0%	0%	0%
Is too difficult for weaker students	37%	50%	0%	13%	0%
Provides a common language for communication about science	0%	0%	0%	63%	37%
Is a good approach for a teacher who lacks experience in science	0%	25%	13%	50%	13%
Makes assessment difficult	25%	62%	13%	0%	0%
Professional development opportunities in this field are inadequate	25%	25%	13%	25%	13%

Do you use open-ended science investigations in your classroom teaching?

100% of the teachers who answered this question state that they use open-ended science investigations in their classroom teaching.

How many years have you used open-ended science investigations in your classroom?

Seven teachers responded to this question, with their answers ranging from 4 - 30 years.

- 14% has used open-ended science investigations for 30 years,
- 14% for 25 years,
- 14.3% for 12 years,
- 43% for 5-10 years, and
- 14% for 4 years.

What school level/grades have you used open-ended science investigations?

One teacher, who responded exclusively from a primary school context, has stated that open-ended science investigations are used in both years 5 and 6. The other six teachers responses include the high school context, 17% have used open-ended science investigations in years 3 and 4, 33% in years 5 and 6, 67% in year 7, 100% in year 8, and 83% in years 9, 10, 11 and 12.

Does your whole school use open-ended science investigations?

Of the teachers who responded, 57% stated that they believed their whole school used open-ended science investigations and 43% reported that their whole school does not.

Can you please estimate the number of hours of professional development you have undertaken to gain teaching skills for open-ended science investigations?

Teachers reported varied amounts of professional development when it came to obtaining teaching skills for open ended science investigation. Fourteen per cent reported only their study from university, 14% reported zero official professional development hours, 14% stated they had completed five hours, 14% having completed 10 hours, 14% having completed 15 hours and 29% stating they had completed 40 or more hours, with one teacher commenting that the amount of hours was *"hard to estimate - extensive over many years, e.g. 4 x 30 hours".*

Identifying what form of professional development teachers have undertaken for open-ended science investigations.

Fifty-seven per cent of the teachers who responded acknowledged that they had completed professional development with a trainer (not the whole school), 29% stated that they had completed a train-the-trainer program, 29% had completed a whole school face-to-face workshop, 29% had completed do-it-yourself programs, 14% stated they had completed no professional development and 14% explained that they had participated in, *"conference seminars/workshops; on the job mentoring and teacher peer observations".*

6. Teacher experiences

An overview is provided in this section of teacher reflections on their motivations, awareness, and the benefits and challenges associated with the BHBPSEA.

6.1 Motivation to be involved with the BHPBSEA

Fifty-six per cent of teachers identified their participation as being motivated by the benefit the BHPBSEA has to students, with one teacher stating, *"Student research projects are an opportunity for them to indulge their scientific passions. The BHPBSEA gives students an out of school context for completing their projects and this experience adds to the intrinsic engagement for students..."* another teacher explained that, *"It is a great opportunity for students to gain recognition for their hard work and scientific interests".*

Other teacher's responses fell into the following categories: personal interest in perusing investigations with students (22%), to gain experience and to develop as a teacher (11%) and to encourage open-ended investigations in schools (11%).

6.2 Main barriers to teachers taking part in the BHPBSEA

Many of the teacher participant outlined multiple barriers they had encountered. The most frequently suggested barrier is that of time (47%), this included teachers not being able to access time off work or release time to organise or participate in BHPBSEA submissions with one teacher stating, *"The time factor is the major barrier. Trying to get through all the course content in the Australian Curriculum, Science plus allow sufficient time for students to do meaningful open-ended investigations can be challenging..."* with another suggesting, *"Organising advanced science investigations takes a prohibitive amount of time for most teachers. This includes finding suitable mentors, monitoring progress, attending meetings, ensuring deadlines are met - all on top of a normal hectic teaching load"*.

Other barriers expressed by teachers included: access to resources and funding (20%), confidence - teachers not feeling qualified to help with engineering submissions or don't feel they would qualify for the awards (20%) and the difficult application process (13%).

6.3 Involvement with students who have entered science research competitions

The teacher responses were quite varied on this topic, with some teachers outlining multiple areas in which they were involved with students who have entered science research competitions. Twenty-five per cent of teachers when responding to this question stated that their 'involvement with students' was more to do with supporting other staff to participate with one teacher explaining, *"As science coordinator at this and past schools ... I have supported my staff and students to take part in research based learning and competitions for the past 30 years".*

Other areas of involvement suggested included: using their professional network to help students (17%), mentoring both staff and students (17%), encouraging and supporting all students to enter competitions (8%), give up personal time (8%), editing drafts (8%) and escorting winners (8%).

6.4 Student research competitions impact on teachers

Teachers were asked to reflect upon their own practices, perceptions in schools and the impact on them. Below is a summary of their responses.

Own or other teacher's pedagogy and assessment

Fourteen per cent of teachers who responded stated that their own or other teachers' pedagogy and assessment had only been impacted 'a little' by their involvement in the student research competitions. While the significant majority (86%) stated that this impact was 'significant' (29%) or 'very significant' (57%).

Judges also reflected upon the quality of the teacher practices they came across from the judging process. The majority of judges (67%) responded that the teaching practices they encountered were of high quality, with one stating, *'I was very impressed with what teachers were doing in their schools. They were involving scientists, engaging students in real life science and developing amazing units of work"*. Another participating judge explained that teaching practices were representative of *"all the qualities identified above"*.

In addition, 100% of judges believed that the BHPBSEA attracts and rewards genuinely high quality science teaching, with three judges stating:

> *"I was particularly impressed by what teachers were doing in their schools and their willingness to go beyond what is expected."*
>
> *"The pedagogy that was included in the applications were practices that I would expect from experienced and competent professionals."*
>
> *"Teachers who win awards demonstrate the required attributes of a highlight effective science teacher".*

Perceptions within schools concerning the value of such activities

Fifty-seven per cent of teachers believe that the perceptions within schools concerning the value of research science competitions was significant and 43% believe that this impact was 'very significant'.

Has the BHPBSEA had an impact on you?

Of the teachers who responded to this, 100% stated that the BHPBSEA has had an impact on them. When asked to elaborate on this, their answers fell into three categories:

1. Attended the awards (45%),
2. Student benefit and success (33%), and
3. Increased motivation (22%) with one teacher stating, *"Being a state finalist in 2015 was a terrific honour and seeing several of our students achieve awards has been gratifying".*

The majority of the responses received from judges indicated that they felt teachers were 'extensively' impacted across their pedagogy and assessment practices, attitudes towards open-ended investigation, perceptions of value to schools and self-esteem (see Figure 4).

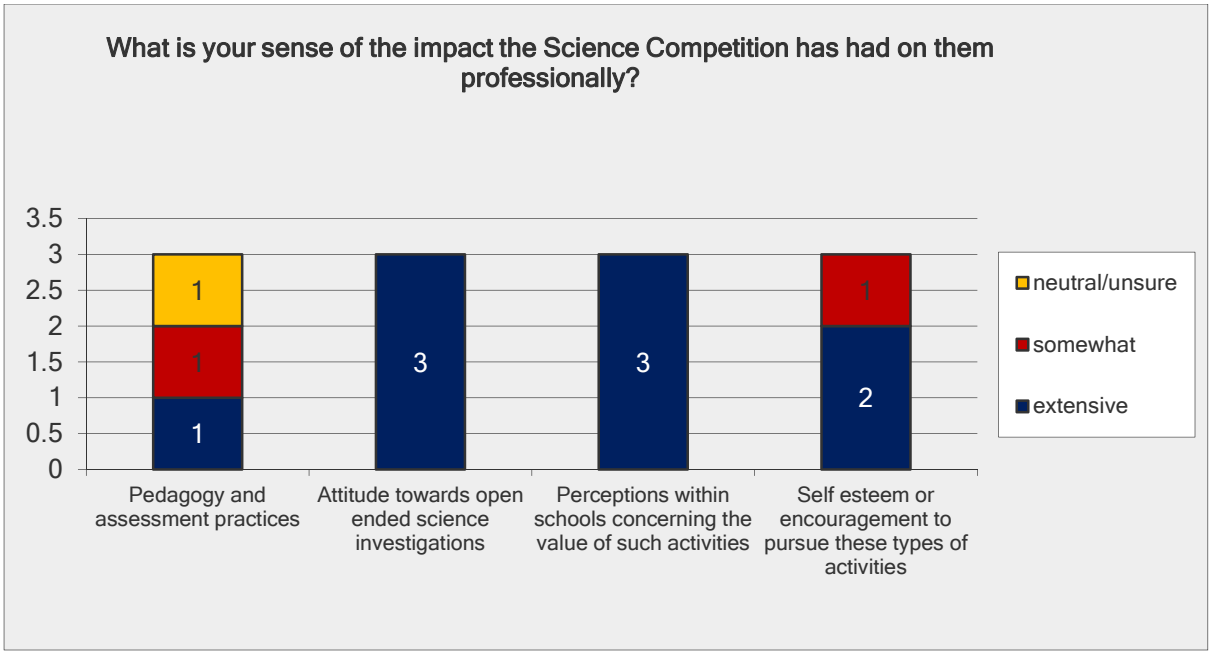

Figure 4. Impact on judges personally and professionally

7. Development of judges

This section provides a summary of reflections on the factors contributing to the professional and personal development of those that participate as judges.

7.1 Areas of importance when judging students

Judges were asked to reflect upon their perceptions of various aspects involved with student submissions to and experiences with the BHPBSEA (Table 19). From a judging criteria perspective, the mainstream response was that quality of the science displayed was very important (58%), as well as the level of innovation and creativity (84% responded important or very important), improvement in skills and understanding from their project (83%) but also the nature of science (83%). All judges (100%) reported how very important it was that the awards improved student engagement with science, along with their attitudes. Just over 75% of judges found it important or very important for the BHPBSEA to have an effect on student aspirations to continue with science, or more generally on enrolment patterns.

Table 19. Important aspects of student submissions and experiences

On a scale of 1 (not at all) to 5 (very important), how important would you rate the following aspects of student submissions and experiences of the Award scheme:					
	not at all	unimportant	neutral/unsure	important	very important
Quality of the science that students display in these projects	0%	8%	8%	25%	58%
Level of innovation or creativity or science investigative skills that are displayed	0%	0%	17%	42%	42%
Improvement in science skills or understanding that may have been a result of the awards	0%	8%	8%	50%	33%
Improvement/confidence in communicating science ideas	0%	8%	0%	42%	50%
Student understanding of the nature of science	0%	0%	8%	58%	33%
Student engagement with science	0%	0%	0%	42%	58%
Attitudes to science	0%	0%	0%	67%	33%
Effects on their aspirations to continue with science, or more generally on enrolment patterns (secondary or tertiary science)	0%	8%	17%	33%	42%

7.2 Areas of importance when judging teachers

Participating judges provided insights in the list of important traits/behaviours/approaches they were looking for in teachers when making their decisions. A total of six themes were identified:

1. How they support students (25%),
2. How they promote science (25%),
3. Passion (13%),
4. How they support other teachers (13%),
5. Innovation (13%), and
6. Ability to motivate students (13%).

7.3 Impact on judges

Judges were asked if the experience of acting as a judge impacted on them personally or professionally. Some of the judges provided additional qualitative responses. Their responses were summarised into four key themes and included:

1. I was inspired/humbled (31%),
2. I have learned from this experience (25%),
3. It was very rewarding (19%), and
4. I was frustrated by the final judging choices (6%). One comment to represent this sentiment is provided below.

   "I enjoyed the experience but on both occasions I came away feeling quite frustrated by the final choices of the judging panel. In my first year I reconciled this as me being new to the process but in year 2 I was convinced of my opinions, made them very clear but was comprehensively out-voted. I appreciate that this is a significant statement to make but I felt that some of the other judges were actually being overly harsh on some of the female candidates. In a competition such as this where there is always some subjectivity and where there is a significant gender imbalance I felt that, where things were more or less equal, greater weight should be given to the girls. This argument was dismissed by the other judges in both years. There are judges who have been doing the role for a long time which does bring some benefits but it is also possible that getting totally new people might be a good thing."

8. Link to state science awards and initiatives

This section of the report provides a reflection on the influence of the BHPBSEA on the development of other state science awards and initiatives.

8.1 Influence of the BHPBSEA on State programs

Key stakeholders were asked to reflect on what, if any, influence did they see to their Awards/Program/Organisation's due to BHP Billiton adding engineering to the Awards scheme. The following themes were identified from the responses:

- Increased participation/ interest (50%), with one participant stating, *"This helped open up another area through which students could participate that covered the full range of STEM subjects"*,
- Enabled students to display their skills/talents for engineering (33%), and
- Improved creativity/ problem solving skills (17%).

8.2 Addressing Australia's STEM issues

Key stakeholders were asked for their reflections on how they see initiatives, such as science and engineering awards and competitions, assisting with addressing Australia's STEM issues. A vast range of responses were received.

A quarter (20%) of the key stakeholders commented that these initiatives assisted by encouraging inquiry-based learning in classrooms, and a further 20% suggested they have post school/'real life' benefits with one stakeholder commenting that *"these awards are a way of promoting STEM. Students get the opportunity to work like a scientist/engineer and maybe realise it is a possible carer option."*

Other suggestions included: improved student engagement (13%), student recognition (13%), increased interest in STEM studies (13%), promotion of excellence (7%) and promotion of STEM in schools (7%).

One stakeholder made the following suggestion: *"I see them as one of 900 such activities across Australia. We need to scale the number of STEM activities back, consolidate the funding into one big pool and fund only 6 or 7 activities across the nation (rather than a limited specific geographic focus)."*

9. Overall feedback on the BHPBSEA

This section provides a summary of all the feedback and ideas provided in regards to the BHPBSEA.

9.1 Areas for improvement

All stakeholders had ideas for improvements to the BHPBSEA.

Students

Students who provided an additional comment to this question collectively outlined 15 key responses, yet 28% of students commented that they could not outline any areas of improvement, with one student stating, *"Just keep doing what you've been doing - it's a great opportunity for students who are interested in science to work like a scientist and see how many other great ideas out peers are investigating".*

Areas for improvement are summarised below:

- Less time between submission and announcement (13%),
- Better communication between entrants and BHP (9%),
- Improved scaffolding to make it less challenging (9%),
- Improved feedback (4%),
- Encouraging open-ended investigation more frequently in class (4%),
- Discouraging the same people from entering each year (4%),
- Invite primary winners to science camp (4%),
- Higher standards for referencing (4%),
- More relaxed criteria (4%),
- Include a marking rubric (4%),
- Improved promotion of awards in schools (4%),
- Support in schools from professional scientists (4%),
- Sharing of past students submissions (4%), and
- Returning submissions to students to allow them to continue their research/ project (4%)

Teachers

Fifty-seven per cent of teacher participants suggested some areas of improvement, these included:

- Improve the promotion of the awards,
- Improved resources offered to teachers (list of potential topics, small engineering tasks etc.),
- Simplify the application process, merge CREST applications where possible,
- Greater recognition of students who did not progress/attend the science camp, and
- Timing and feedback were also outlined as being able to be improved upon.

Judges

Thirty per cent of judges who responded asked for more encouragement to students to gain a greater number of entries, including new schools. One judge commented, *"It would be good to broaden the range of schools. The entrants are highly concentrated from certain schools and even certain families!"*

Other answers included: put a limit on the size of submissions (14%), increase funding (14%), require a better filter on material submitted (14%), electronic marking software (14%), more emphasis on teacher awards (14%), and the awards need more promotion (14%).

Key stakeholders

Eight suggestions were made by the key stakeholders. These suggestions are weighted equally (12.5%) and include: Growing the awards into a major national event, improving promotion, supporting students in finding an initial 'driving question', creating a blog of past winners to connect with current participants, more prizes, limiting the size of submissions, letter of thanks/appreciation to students not selected as a finalist, invite more students to camp, potentially as state ambassadors, not participants).

In addition, nine categories were outlined by key stakeholders in the answer to the question: What aspects of the BHPBSEA Award do you think are good and should be retained? The main response was to retain the finalist camp (20%) and awards ceremony (20%), to which one stakeholder responded that *"the awards ceremony and the camp provide student finalists a rewarding and valuable experience, while sending the right message to our future scientists".*

Other responses were: acknowledging teacher excellence (13%), acknowledging student excellence (13%), resources supporting teachers and students (7%), flexibility (7%), accessibility to extend on other competitions submissions (7%), presentation of work to judges (7%) and giving real life experience to students (7%).

9.2 Final comments

At the conclusion of the data collection methods, all participants were asked if they had any further comments in regards to the BHPSEA or science and engineering competitions in general. Below is a summary of these comments.

Students

Twenty-seven students responded to this question, the majority of students answered in a resoundingly positive way with 76% praising the competition, making statements such as, *'made me feel normal', 'great experience', 'inspiring', 'encouraging', 'a new opportunity', 'fun', 'thank-you',* stating that they would compete again, congratulating primary involvement, improved learning and that the awards were a great investment in science education.

Other comments included:

- Struggles with the video component (3%),
- Urging to consider entrants with impediments or disabilities (3%),
- Asking to tighten restrictions on the amount of external 'help' allowed (3%),
- Asking to return student submissions (3%),
- Encouragement to explore student outcomes after the awards (3%),
- Request to improve promotion and encouragement for students to participate in awards (3%), and
- Request to invite more students to the science camp (3%).

Teachers

Teacher 1:

> *"I loved being a finalist and although I didn't win the national comp, I will always cherish my special time. BHP was a great host as were Vicki and Vic Dobos. The two things that left me a little deflated were my interview which bombed out badly as a result of Skype breaking up, and the fact our 7 minute presentations counted for nothing. Is it possible that interviews are scheduled as part of the Melbourne itinerary for finalist so that it is a face-to-face arrangement?? Also that the presentation actually accounts for something such as 20-30% of the overall deliberations? These changes I believe would make it totally fair and transparent for all finalists."*

Teacher 2:

> *"Entry only through CREST and state competitions could perhaps be relaxed or reviewed. The process of entry seems slightly "elitist" compared to other science inquiry competitions. The feedback process could also be improved both for the student and teacher competitions."*

Judges

Six judges provided a few final comments at the end of their survey. The majority were positive in nature and covered the advantages and benefits the BHPBSEA provides to both students and teachers, as well as reflecting upon the enjoyment they experienced as a judge. One additional idea pitched by one judge was the suggestion that team challenges be encouraged over the overwhelming submission of individual projects.

Positive

> *"The science and engineering competitions allows the creativity, perseverance and excellence of our students to be seen and celebrated. It is an amazing experience to interact with these students and experience their enthusiasm for science. They are excited and stimulated to be able to interact with other students with similar passions."*
>
> *"The competitions seem to bring out the best in the students; they enter with goodwill and are genuinely pleased when they are selected as finalists. The experience on the BHPBSEA camp is cited by the students as a highlight."*
>
> *"These are very worthwhile for both the students and teachers involved. They provide something for both groups to aspire too and should be continued."*
>
> *"I really enjoyed working with the other judges and the BHPSEA staff. I had a good time and was well taken care of."*
>
> *"I learnt a lot about the current science teaching by the projects submitted and wonder if there needs to be more done to teach teachers how to set up and conduct hands on investigations."*

Negative

> *"It might be good to ask for team challenges rather than individual challenges there are a variety of other science student prizes out there and I am not convinced that this stands out from the rest."*

Key Stakeholders

A total of five stakeholders responded to this question, providing further comments. These included:

- Great competition/ I will continue to participate (33%),
- Going on to INTEL ISEF is a fantastic opportunity for students (22%),
- Create partnerships with universities (11%),
- Further highlight and promote the teacher awards (11%),
- Great for students to make like-minded friends (11%).

One stakeholder suggested the combination of competitions, stating, *"Should the awards become part of other competitions so that competitions don't compete for entries but value-add to other successful initiatives and provide a greater draw for entries? Teachers and students are time poor so having more competitions won't attract more entries but maybe having bigger competitions or one registration point and one entry fee where entries can be allocated to specific competitions might be attractive to teachers and students".*

10. Media analysis results

Below is a summation of the descriptive characteristics of the entire BHPBSEA media library, collected during the 2014 period only.

10.1 Descriptive characteristics of the entire BHPBSEA media library

The following table shows the 33 news sources and the number of articles/related segments that were found in each. The Highest Number of articles were produced by CSIRO (16%). This was followed by WIN TV (12%) and GEM TV – All Australian News (11%) and ABC AM Radio (11%). The majority of news sources were generated from reports or segments in Australia (91%), followed by China (6%) and the United Kingdom (3%).

Table 20. News source and number of articles analysed

Country	News Source	Frequency	%
Australia	CSIRO	9	15.8
Australia	WIN TV	7	12.3
Australia	GEM TV – All Australian News	6	10.5
Australia	ABC AM Radio	6	10.5
Australia	Scienceawards	1	1.8
Australia	SYN FM Radio	1	1.8
Australia	6PR AM Radio	1	1.8
Australia	Dandenong Journal	1	1.8
Australia	City News	1	1.8
Australia	The Gympie Times	1	1.8
Australia	Science Teachers Association of QLD	1	1.8
Australia	Veski	1	1.8
China	News Xinhaunet	1	1.8
Australia	Progress and Control Engineering	1	1.8
United Kingdom	My Science Academy	1	1.8
Australia	The Queensland Times	1	1.8
Australia	The Sydney Morning Herald	1	1.8
Australia	Australian Mining	1	1.8
Australia	Motoring.com.au	1	1.8
Australia	The Advocate	1	1.8
China	china.org.au	1	1.8
Australia	Electronics News	1	1.8
Australia	Manufacturer's Monthly	1	1.8
Australia	ICTCareer	1	1.8
Australia	Executive Career	1	1.8

Australia	The Herald Sun	1	1.8
Australia	labonline	1	1.8
Australia	The Age	1	1.8
Australia	Cowra Community News	1	1.8
Australia	Central Telegraph	1	1.8
Australia	Ferret	1	1.8
Australia	The Australian Business Review	1	1.8
Australia	Illawarra Mercury	1	1.8

10.2 Article content

The figure below provides the frequency of the words used to describe BHPBSEA found in each of the articles. The most frequently occurring term was "*prestigious*" which occurred in 30 articles, followed by "*school science competition*" (n = 20). The other terms, which occurred less frequently, were:

- practical research projects
- innovative approaches
- national awards
- great challenges
- for high school students
- managed by CSIRO
- sponsored by BHP Billiton
- educational opportunities
- victory for engineering and innovation

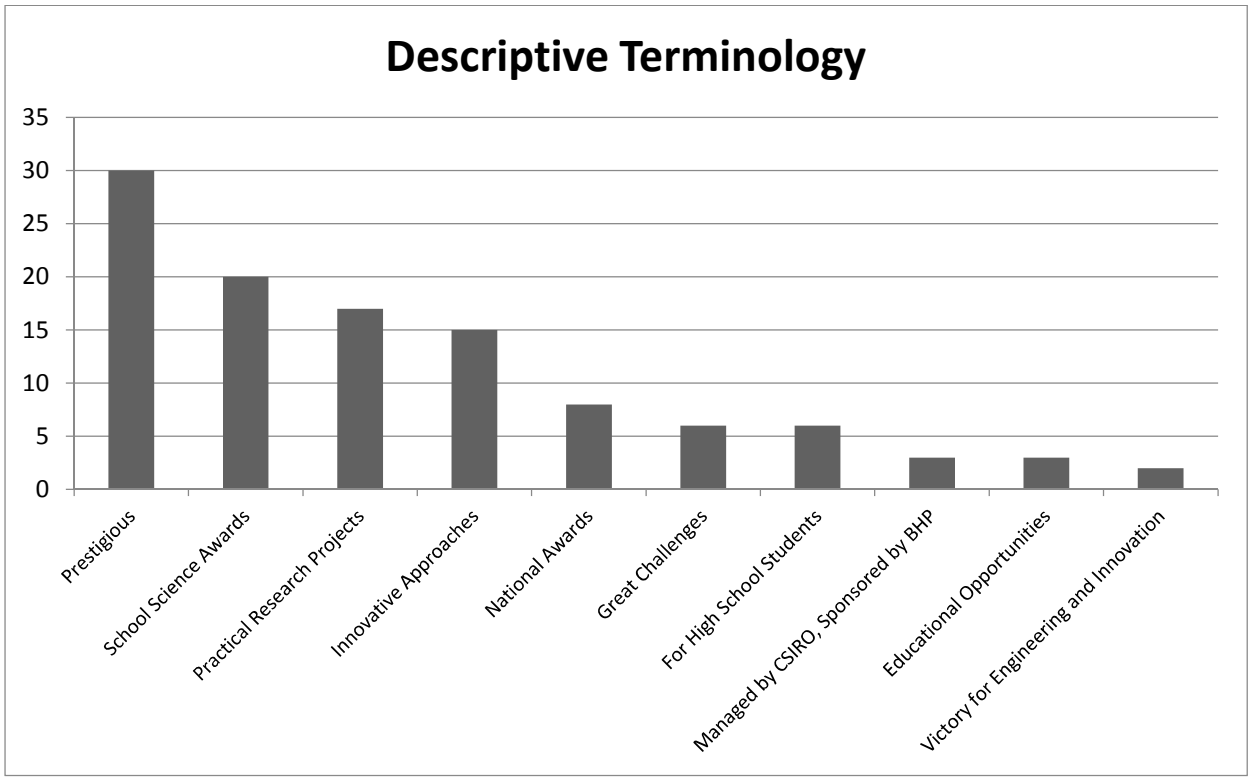

Figure 5. Frequency of words used to describe BHPBSEA found in each of the articles

10.3 Article focus and tone

Examination of each article to understand the extent to which BHPBSEA was a focus revealed that of the total 57 articles and segments there was an uneven split across the three categories primary, secondary, and peripheral. Fifty-one articles (90%) had BHPBSEA as the primary focus of the article. Six articles (11%) were of a secondary focus, where the article primarily focused on a related topic with substantial reference to BHPBSEA (see Table 21).

Table 21. Article focus

Focus	Positive	Negative	Balanced	Neutral	Total	%
Primary	33	0	0	18	51	90%
Secondary	3	0	0	3	6	11%
Peripheral	0	0	0	0	0	0%

Secondly, the articles were assessed for tone, that is, were they balanced, negative, neutral, or positive. All articles within the media analysis were either of a positive or neutral tone. Thirty-seven percent (n = 21) were neutral in their reporting, and the remaining 63% (n = 36) were positive about BHPBSEA (see Figure 6).

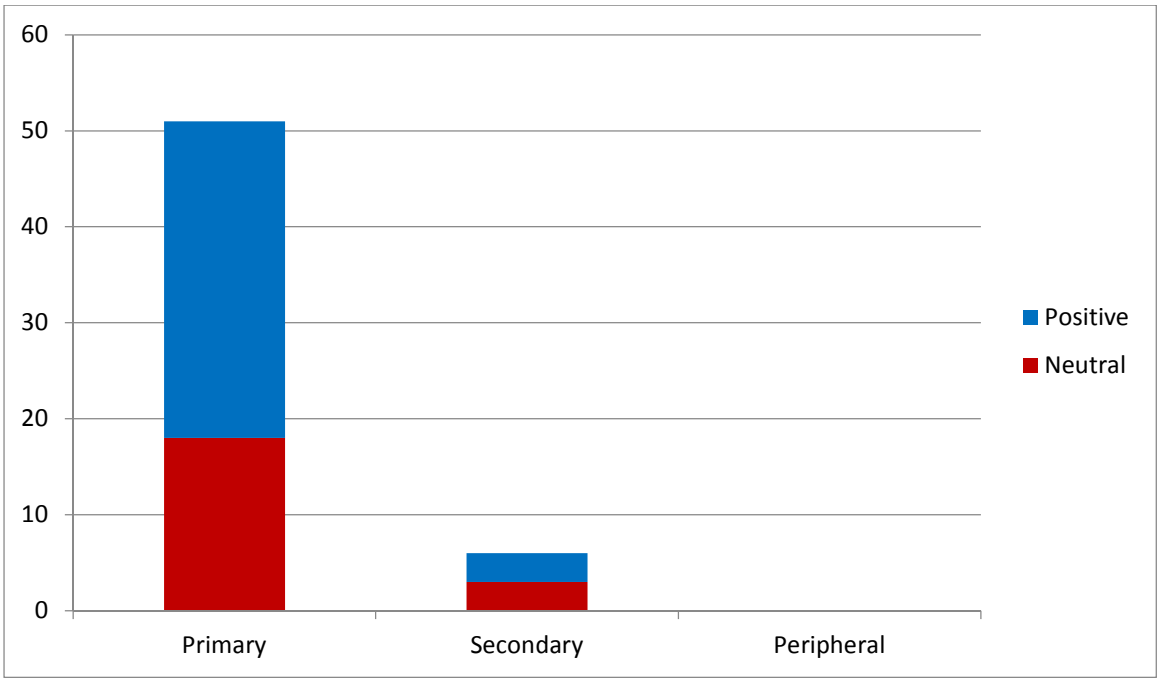

Figure 6. Focus and tone of articles

There was a strong bias to which country dominated the BHPBSEA literature. Figure 7 depicts the number of articles from the various countries included. Australia has the largest number of articles represented however, given that BHPBSEA are Australian awards, this is to be expected.

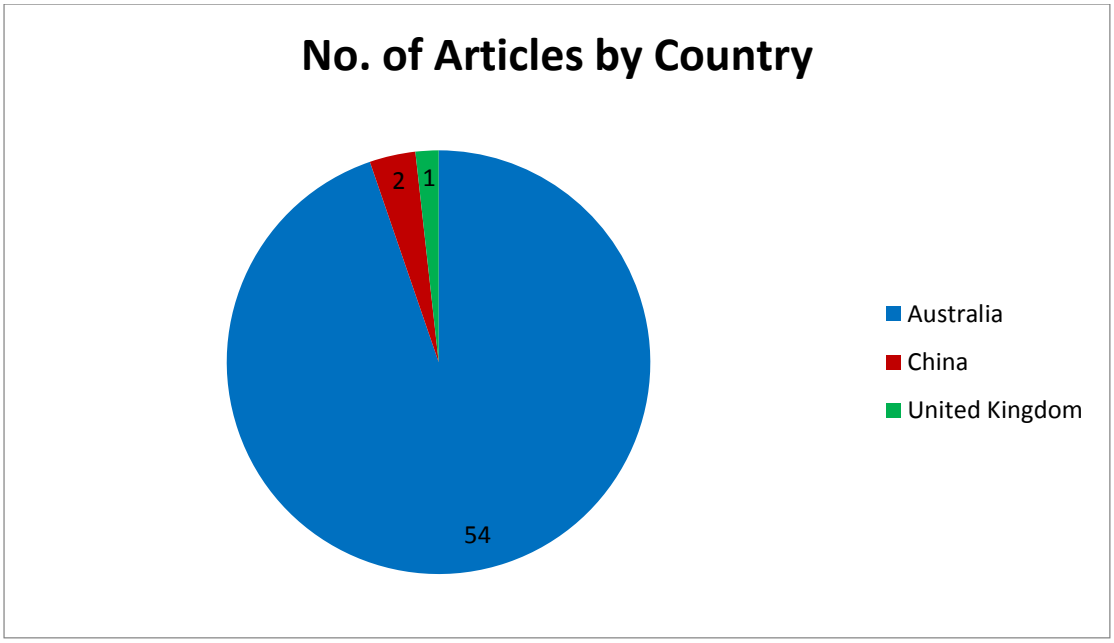

Figure 7. Country breakdown

10.4 Technical Accuracy of BHPBSEA

In terms of conveying technical accuracy, 54 (95% - combination of the basic and detailed percentages) out of a total of 57 articles, attempted to define or outline BHPBSEA for the reader (see Figure 8). Of these, 17 (32%) only provided a brief outline, while the majority, 37 (67%) of articles explored BHPBSEA in more depth. The detailed articles were more likely to explain the process of the BHPBSEA or the types of submissions entered.

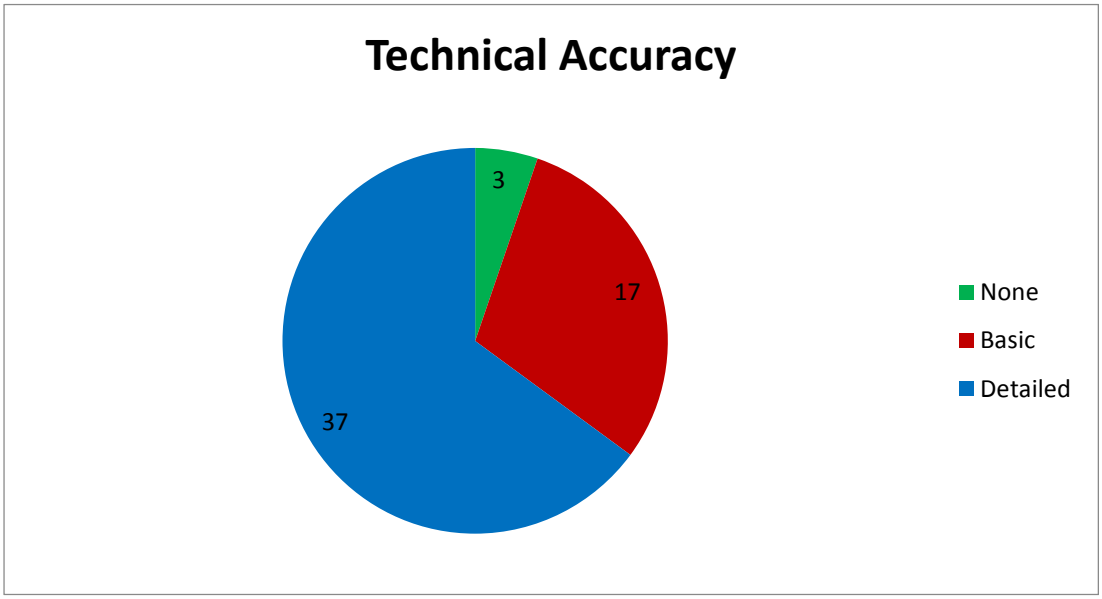

Figure 8. Technical accuracy

10.5 Timing

The graph below (Figure 9) highlights the spread of articles reviewed across the 11 months of the media analysis and identifies peaks in coverage during this period, while Table 22 shows the dates in which BHP Billiton Science and Engineering winners were announced. Media interest is peaked in February 2014 when winners are announced, and also in the lead up to this announcement. After

March 2014, media interest doesn't begin to rise again until January 2015, one month before the 2015 winners are announced.

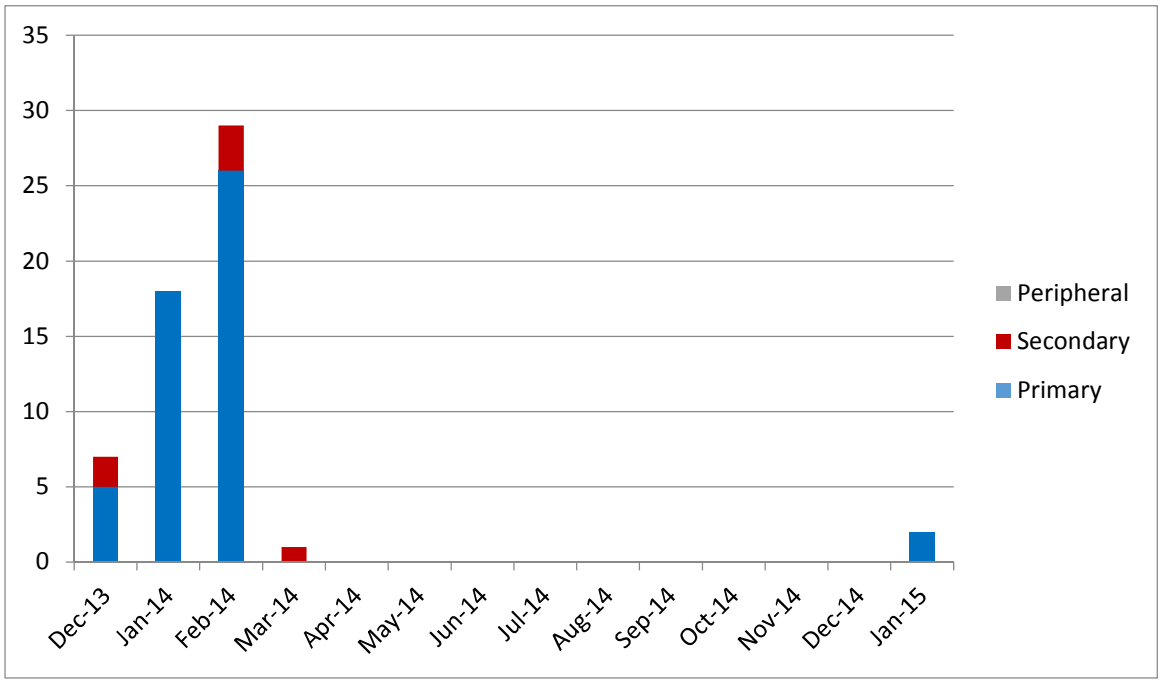

Figure 9. Timing and number of articles per month

Table 22. Announcements

Date	Region	Even/Announcement
04/02/2014	Melbourne	2014 BHPBSEA Winners Announced
03/02/2015	Melbourne	2015 BHPBSEA Winners Announced

10.6 Top Media Sources who write frequently about BHP Billiton Science and Engineering

Table 23. Top media sources

Media Source	No.	BHPBSEA Focus		Tone	
		Primary	Secondary	Positive	Neutral
CSIRO	9	9	0	8	1
ABC Radio	6	6	0	4	2
WIN Television	7	7	0	5	2
GEM Television	6	6	0	0	6
Illawarra Mercury	1	1	0	0	1
Herald Sun	1	1	0	1	0
The Australian Business Review	1	0	1	0	1
Ferret.com.au	1	1	0	1	0

Central Telegraph	1	1	0	1	0
Cowra Community News	1	1	0	1	0
The Age	1	0	1	0	1
Labonline.com	1	1	0	1	0
Executivecareer.net	1	1	0	1	0
ICT Career	1	1	0	1	0
Manufacturers Monthly	1	1	0	1	0
Electronics News	1	1	0	1	0
China.org	1	1	0	1	0
The Advocate	1	1	0	0	1
Motoring.com	1	1	0	0	1
Australian Mining	1	1	0	1	0
The Sydney Morning Herald	1	0	1	0	1
The Queensland Time	1	0	1	1	0
My Science Academy	1	1	0	0	1
Progress and Control Engineering	1	1	0	1	0
News Xinhuanet	1	1	0	1	0
Veski	1	1	0	1	0
Science Teacher's Assoc. of QLD	1	1	0	1	0
The Gympie Times	1	0	1	1	0
City News	1	0	1	1	0
Dandenong Journal	1	1	0	1	0
6PR Perth Radio	1	1	0	0	1
SYN FM Radio	1	1	0	1	0
Scienceawards.org	1	1	0	0	1

10.7 Key Themes Arising from Entire BHPBSEA Library

In total, 18 key themes were identified as being repeated across the entire BHPBSEA media database. Figure 10 depicts the frequency percentages for each of the themes. The most frequent themes in the media were highlighting individual student's submissions (16%), followed by “Finalist Submissions” (9%), “The Importance of Science and Engineering to Society” (7%), “Why CSIRO Supports the Awards” (7%), “When the Winners will be announced” (7%) and “The Winners Submissions” (5%).

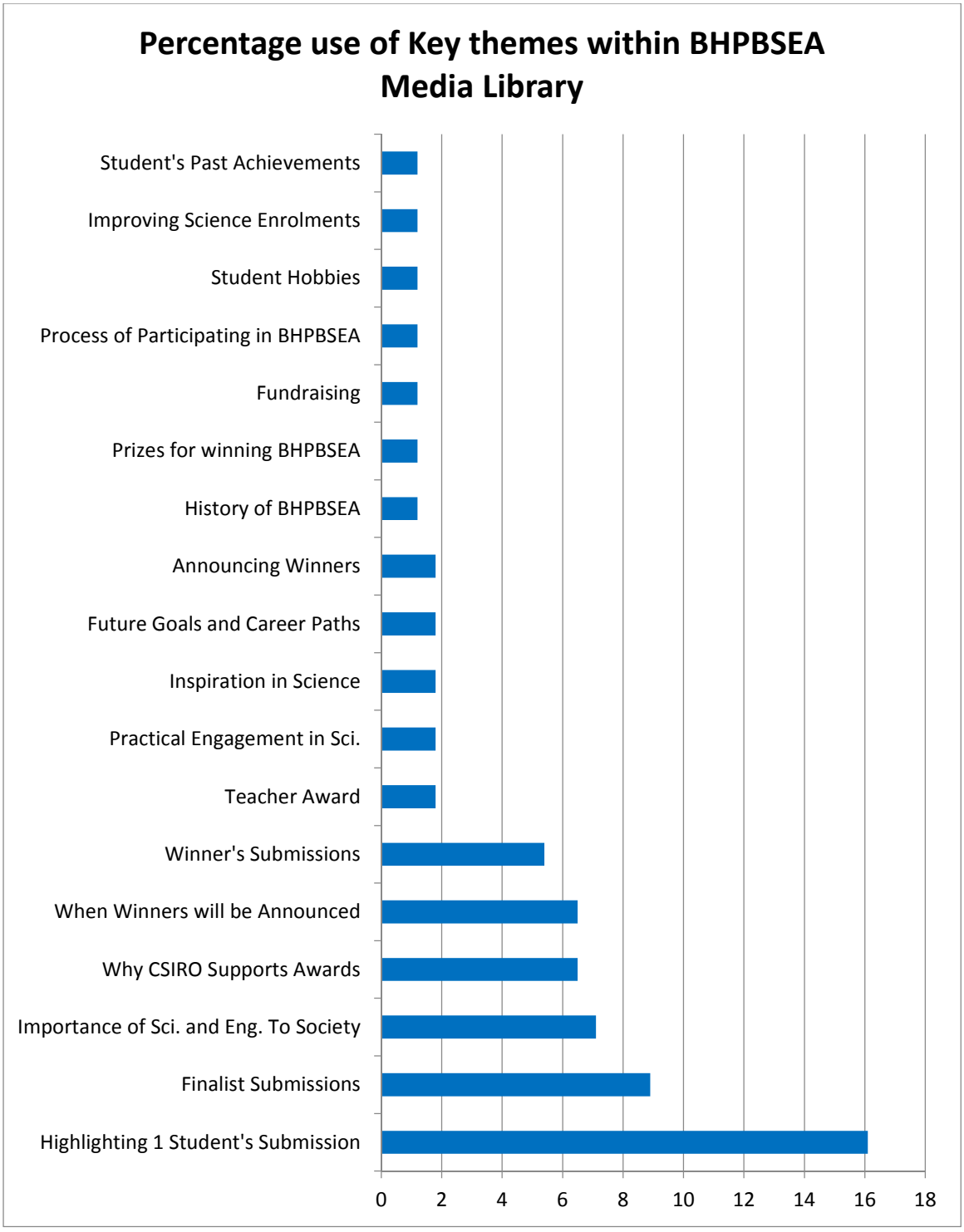

Figure 10. Key Themes arising from content analysis

It can be suggested that the positive nature of the key themes is likely to have a correlation to the high percentage of articles that were found to be of a positive tone. The majority of the articles related to student submissions in some capacity, and supported the importance of science and engineering to society. It is this positivity that has likely impacted on the previous data relating to the media analysis.

PART 3: Conclusions and recommendations

11. Conclusions

The table below provides a summary of the key findings across the evaluation criteria.

Table 24. Summary of the evaluation criteria

Evaluation area	Comments
Improvements to student skills (e.g. science, engineering, experimental research, and communication).	Overall, the BHPBSEA has contributed to the development and improvement of the following skills in students: • Science & engineering knowledge and skills • Open-ended investigation • Math • Communication • Time management In addition, the majority of students (51%) agreed or strongly agreed that the BHPBSEA helped them to achieve better academic results in science. Other recognised benefits to students were: • Increased knowledge & learning • Future study & career pathways • Networking & making friends • Gaining recognition • Increased interest in science • The opportunity to share ideas • Real-life application of science and engineering • Increased confidence • Sense of achievement • Being inspired • Sense of pride • Problem solving skills • Challenging themselves • Winning prizes • Improved group working skills • Report writing • Independent learning • Improved research skills • Improved resilience • Increased curiosity
Positive changes to student attitudes and perceptions towards science/engineering/technology subjects, experiences with research projects and awards, as well as STEM career aspirations.	Not surprisingly, the majority of participants see themselves as being good at science as well as enjoy and look forward to their science classes at school. The student survey participants also had a history in being interested in science or engineering and view studying science as "cool". In addition, the participants view science as among the most interesting things they do in school and believe more time should be spent on science each week. Therefore, the students already possessed strong positive attitudes towards science/engineering/technology subjects, which the BHPBSEA provided more of an opportunity to spend doing a project in this chosen area of interest but also to gain acknowledgement and recognition for their efforts. One area of contradiction was between teacher perceptions on who would be suited to the BHPBSEA initiative and who actually participates. Teachers reflected that the BHPBSEA is not just for the "usually engaged student" but

	can be for those with less focus or interest in science and/or engineering. Yet the data suggests that those less energetic students are not participating and would need to be strongly encouraged and provided more assistance than those students with existing high levels of interest and academic abilities to design, complete and submit an investigation to the BHPBSEA. The main draw card for students to gain experience with a research project was the freedom to choose their own topic to explore. The ability to choose a field that a student is most interested affected their overall enjoyment and learning from the investigation but also their aspirations to have science/engineering as a career option. It is was strongly stated from many of the participants that this element of the initiative be retained. Other factors contributing to positive attitudes and behaviours due to involvement and experiences with the BHPBSEA were: • Actual 'doing the experiment/investigation' • Learning new skills' • Investigating a topic of interest or importance • Meeting like-minded people • Learning/ gaining knowledge • Increased confidence • Completing the investigation • The combination of science and engineering • Having autonomy • Preparing for further education Overall, the majority of students viewed the open-ended investigation approach as an opportunity to pursue their topic of interest. The approach was seen to support the chance to go beyond regular exercises set in the classroom and do experiments that were different to everyone else. Yet, 37% of the student participants did reflect the inability to be flexible beyond the regular classroom laboratory exercises. Therefore, not all student experiences are the same in regards to options and flexibility on investigation topics due to either barriers related to curriculum or teaching styles. In addition, it also appears that once a topic is chosen (whether independently or directed), the design and best way to carry out the experiment is heavily influenced by the student's teacher. There was evidence that some students (28%), thanks to their participation in the BHPBSEA, have decided to pursue a career in science or engineering. Although the opportunity and experience in the BHPBSEA was enjoyed and beneficial to students, 44% indicted that they would have pursued a career in science or engineering anyway. In summary, the BHPBSEA did have an influence on student attitudes towards science and engineering, with 64% of participants acknowledging that the experience had a positive effect and 49% indicating that their participation has shifted the way they think about science and engineering.
Contributing to the decision making process by students to continue with science at senior secondary and tertiary levels of education.	Evidence shows that the BHPBSEA has contributed to the interest levels in students in regards to science and engineering. The flow on effect of this has contributed to students intending or actually enrolling in science subjects at the secondary, as well as, the tertiary levels. Students were more inclined to identify science as the university course most likely to be their academic pathway, but this was most likely a reflection of the bias in the data due to significantly more science award participants responding to the survey.

	Only 29% of teachers felt as though the BHPBSEA may have been an influencing factor related to the increase in student enrolment in science subjects, with 71% being unsure of the correlation.
Supporting and raising awareness of teacher experiences of open-ended investigations in science classes.	Eighty-six per cent of teachers agreed that the science research competitions relate to their school's science curriculum, while 14% responded that they do not. This response was influenced by the state in which the participating teacher was located. Greater consistency in Australia's science curriculum could address the misalignment between the aims of science and engineering initiatives and what is taught in classrooms. Twenty-nine per cent of teachers stated that their own and other teachers' attitudes towards open-ended science investigations had been significantly impacted by their involvement in student research competitions and 71% reported that there was a very significant impact. In addition, both teachers and key stakeholders agree and strongly agree that across multiple aspects relating to the open-ended investigation approach, the method has positive outcomes for students and teachers. Teachers reported varied amounts of professional development when it came to obtaining teaching skills for open-ended science investigation. With 56% of teachers having less than 10hrs of PD, this is seen as a clear area for further growth and development. When looking at what PD channels to use, 57% of the teachers who responded acknowledged that they had completed professional development with a trainer (not the whole school), 29% stated that they had completed a train-the-trainer program, 29% had completed a whole school face-to-face workshop, and 29% had completed do-it-yourself programs. Overall, teachers using open-ended investigations were overwhelmingly positive about the benefits they saw in regards to the method. This included: • Good source of activities • Increased teacher confidence to teach science • Promotes skill and concept development across the whole class • Helped the teacher to learn science • Kids love it • Meets the requirements of the syllabus • Provides a common language for communication about science Yet, teachers also acknowledged that the approach requires a lot of time for collecting information and resources and that PD opportunities are currently inadequate.
Contributing to the professional and personal development of those that participate as judges.	Judges reflected on how the BHPBSEA impacted on them personally or professionally. Four key themes and included: 1. I was inspired/humbled, 2. I have learned from this experience, 3. It was very rewarding, and 4. I was frustrated by the final judging choices.
Influencing the development of other State Science Awards and initiatives.	Key stakeholders were asked to reflect on what, if any, influence did they see to their Awards/Program/Organisation's due to BHP Billiton adding engineering to the Awards scheme. The following themes were identified from the responses: • Increased participation/ interest, with one participant stating, *"This helped open up another area through which students could participate that covered the full range of STEM subjects"*, • Enabled students to display their skills/talents for engineering, and

	• Improved creativity/ problem solving skills. A lack of overall awareness of the Awards was highlighted by all evaluation participants as well. Judges and Teachers identified possible ideas to assist with this issue: • Run a marketing campaign that targets non-active schools • Have a level in the competition for those just starting at a less sophisticated level – aims to attract those students not already loving and enjoying science but encourages a sense of achievement • Work to have open-ended investigations used by more teachers Key stakeholders were asked for their reflections on how they see initiatives, such as science and engineering awards and competitions, assist with addressing Australia's STEM issues. A vast range of responses were received, with a quarter of key stakeholders commenting that these initiatives assisted by encouraging inquiry-based learning in classrooms, while others suggested they have post school/'real life' benefits. Other responses included: • Improved student engagement • Student recognition • Increased interest in STEM studies • Promotion of excellence • Promotion of STEM in schools.

12. Recommendations

Below is the list of improvement from each of the participating groups:

Students

- Less time between submission and announcement,
- Better communication between entrants and BHP,
- Improved scaffolding to make it less challenging,
- Improved feedback,
- Encouraging open-ended investigation more frequently in class,
- Discouraging the same people from entering each year,
- Invite primary winners to science camp,
- Higher standards for referencing,
- More relaxed criteria,
- Include a marking rubric,
- Improved promotion of awards in schools,
- Support in schools from professional scientists,
- Sharing of past students submissions, and
- Returning submissions to students to allow them to continue their research/ project.

Teachers

- Improve the promotion of the awards,
- Improved resources offered to teachers (list of potential topics, small engineering tasks etc.),
- Simplify the application process, merge CREST applications where possible,
- Greater recognition of students who did not progress/attend the science camp, and
- Timing and feedback were also outlined as being able to be improved upon.

Judges

- Put a limit on the size of submissions
- Increase funding
- Require a better filter on material submitted
- Electronic marking software
- More emphasis on teacher awards, and
- The awards need more promotion.

Key stakeholders

- Growing the awards into a major national event,
- Improving promotion,
- Supporting students in finding an initial 'driving question',
- Creating a blog of past winners to connect with current participants,
- More prizes,
- Limiting the size of submissions,
- Letter of thanks/appreciation to students not selected as a finalist,
- Invite more students to camp, and
- Potentially as state ambassadors, not participants.

From our perspective, the following recommendations are made:

- All participant groups saw a need to increase opportunities to work in teams – it is suggested that the BHPBSEA consider a special 'team category' to help encourage group project work.
- Increase opportunities to connect with mentors, particularly past BHPBSEA students / winners and experts / researchers.
- Make available more PD opportunities for teachers, but also need to address their "time-poor" factor when considering channels of delivery.
- Judges and key stakeholders see initiatives, such as the BHPBSEA, assisting with addressing Australia's STEM issue. It was suggested providers and funders consolidate the number of programs supported to achieve greater impact.
- Development of a detailed communication and engagement plan would assist with awareness as well as taking advantage of media attention in a more strategic manner.

Appendix A: Summary of the previous evaluation key findings and recommendations

Key findings	Recommendations and Opportunities
1. The student awards scheme sits in a productive relationship to the state awards, which provide an impetus for student entries and which are advantaged by the national profile of the BHP Billiton student awards. 2. There are some very impressive stories of enthusiastic teachers and schools involved in the science awards committed to working with students on investigative projects. 3. The existence of the awards encourages teachers and schools to move beyond normal practical work, which is often described as predictable and illustrative rather than representing scientific experimentation. 4. The requirements for entry into the awards have an impact on what some schools do in their formal curriculum. 5. A minority of teachers and schools are involved in the awards schemes. However, the data gathered suggest that participation in science investigative work is increased where it is embedded in the school's curriculum. 6. School trajectories tend to start with individual teachers who gradually build their commitment and success, and who work to support and enthuse other teachers. 7. Often, where schools have been involved with the award schemes over a number of years, they have built up a system of supporting students with investigative skills including critical thinking and communication. 8. Such schools, and networks of schools, build the standard of investigative work through the development of a substantive teacher and student culture sustained by the award scheme. 9. Substantial professional learning is required to run school science research projects yet this tends to occur mainly at a local level through sharing teacher expertise. There is an opportunity to tap into this teacher expertise in a more formal and sustained way to produce professional development to support this work. 10. A major aspect of the operation of the science research projects program in schools is the linking of students and teachers with scientists and local science professionals. 11. The award events such as state displays and the BHP judging and camp play a generative role in acknowledging students' quality work, building student capabilities and standards, and providing motivation to both students and teachers. 12. While there is an absence of quantitative evidence to show that participation in the awards has boosted student engagement with learning or increased participation in science courses and careers, there is universal agreement supported by substantial anecdotal evidence that this is the case. There were also many anecdotes of the activity galvanising disengaged students. 13. While some students have difficulty with aspects of open investigative work, most students respond powerfully to the ownership and independence of open investigations and often characterise this as doing 'real science'. 14. The teacher awards have gone to teachers with an impressive history of innovation and commitment who have often been successful in initiating and supporting student interest in the student awards. These teachers are very active in utilising the	**Recommendations** 1. That BHP Billiton continues to support the BHP Billiton science awards through partnership arrangements with CSIRO and the Australian Science Teachers Association. 2. That BHP Billiton discuss with CSIRO and ASTA how the nature of the STA and CREST and BHP Billiton awards can best be aligned to meet the twin demands of reward of excellence and grass roots support and encouragement of investigative work, and how the nature of the different levels of award and their communication to students can be best managed to strike the best balance between these competing demands. 3. That BHP Billiton considers expanding the teacher award scheme to include recognition of a greater number of teachers at state level for their involvement with quality student work in the awards schemes. 4. That a revised set of aims for the BHP Billiton Science Awards Program be adopted. **Opportunities** A. That action is taken to ensure that the national curriculum for science includes at least freedom, but hopefully also encouragement, for locally relevant science research projects to be part of the normal classroom program for all students during the compulsory years of schooling. The substance of this study provides a powerful set of arguments for so doing. B. That CSIRO and/or ASTA initiates and coordinates moves for a professional development approach and resources to encourage and support teachers to become involved in open research investigative work. The development of such an approach might involve: • A national conference / workshop of teachers with expertise in running investigative work, to share resources and ideas and develop a strategy for a national approach to professional development. • The development, possibly in partnership with state STAs, of a professional development resource package for teachers of science to engage in investigative work. • The development, again possibly in partnership with state STAs, of curriculum resources to support the structured introduction of science inquiry skills, based on experience of teachers and schools involved in the award schemes. • Support by state STAs to organise local science fairs in rural areas as feeder events into the state awards, as a strategy for setting up networks of teachers focused on science inquiry. C. That CSIRO, ASTA and the state STAs explore ways to use their award schemes to encourage quality students and science graduates to consider science teaching as a

award opportunities and they are very generative in supporting quality school science practice. 15. While the power of an award with very high standards and profile was acknowledged, concerns were raised about the need to have a more layered recognition and award system to encourage teachers and students to participate.	career option, as an important contribution to raising the quality of science teaching in Australian schools. D. That some form of recognition is given for people from outside the school system who contribute so much to the learning of school students through their science research projects. This could be done as part of the state award systems.

Appendix B: Student online survey and interview questions

ONLINE SURVEY QUESTIONS

Evaluation information and Informed consent

Demographics (gender, age, school year level, state)

- Origin of entry
- Year of BHPBSEA nomination/participation
- Were you a finalist?
- Number of years the student has participated in the BHPBSEA

Feelings about science, engineering and technology

On a scale of 1 (very boring) to 5 (very interesting), how did you feel about science, engineering and technology **BEFORE** you took part in the BHPBSEA?

- Science
- Engineering
- Technology

BEFORE you took part in the BHPBSEA, how interested were you in a career in science, engineering and technology? Please answer on a scale of 1 (not interested) to 5 (very interested).

- Science
- Engineering
- Technology

Perceptions about BHPBSEA (5 point Likert scale)

- Participating in the BHPBSEA helped me obtain better marks for my science subjects at school
- Participating in the BHPBSEA increased my interest in science
- Participating in the BHPBSEA increased my interest in engineering
- In my normal science class I complete in activities similar to the BHPBSEA, where I get to design and carry out my own investigation
- All the skills I needed to complete the BHPBSEA investigation were learned in my normal science classes at school

Details on their investigation

Open ended response required

Which resources did you use, and how helpful were they? Scale – 1 (not helpful), 2 (a little helpful), 3 (neutral/unsure), 4 (helpful), 5 (very helpful) – Did not use

- Internet
- Books
- Teacher
- Parent/Guardian
- Mentor
- Other students
- Other (please provide details on your answer)

Attitudes towards science in school and in general (5 point Likert scale)

- I look forward to science lessons
- I enjoy the activities we do in science
- What we do in science are among the most interesting things we do in school
- We should spend more time on science each week
- Science is useful in everyday life
- Engineering is useful in everyday life
- I am good at science
- Knowing science helps get a job
- Knowing about engineering helps to get a job
- Studying hard in science is not cool to do
- I have always been interested in science
- I have always been interested in engineering
- I would be interested in working in a science related field
- I would be interested in working in an engineering related field

Attitudes towards open-ended investigations (5 point Likert scale)

On a scale of 1 (never) to 5 (always), using the open ended investigation approach, how often would you have:

- An opportunity to pursue your own science or engineering interest
- Be made to design your own experiments to solve a problem given by the teacher
- See other students collect data for the same problem
- Be allowed to go beyond the regular laboratory exercises and do some experimenting of your own
- Do different experiments to other students
- The teacher decides the best way for you to carry out the experiment

Intentions for enrolment in science and engineering (secondary and tertiary level)

- I will choose some science or engineering subjects in Years 11 and 12
- Involvement in the BHP Billiton Awards contributed to your choice on high school science enrolment.
- I will enrol in science at university
- I will enrol in engineering at university
- The Award scheme experience has influenced your thoughts about enrolling in science or engineering at university
- The Award scheme influenced your attitude towards science or engineering
- I think of science or engineering differently because of the Award scheme
- I would feel the same about science or engineering if I had not got an award

On a scale of 1 (very boring) to 5 (very interesting), how do you feel about science, engineering and technology **AFTER** you took part in the BHPBSEA?

- Science
- Engineering
- Technology

AFTER you took part in the BHPBSEA, how interested are you in a career in science, engineering and technology? Please answer on a scale of 1 (not interested) to 5 (very interested).

- Science
- Engineering
- Technology

Benefits/outcomes from involvement in the BHPBSEA

What was the best thing about the BHPBSEA? (you can tick multiple boxes)

- Freedom to choose the experiment
- Receiving the certificate
- Doing the experiment/investigation
- Learning new skills
- Working in a group
- Working on my own
- Something else (please provide more detail on your answer)

Did the BHPBSEA help with your communication skills? Yes/No

Did you more learn about science or engineering from doing the investigation and being a participant in the Award scheme?

In your own words, what do you see are the benefits from your participation in the BHPBSEA?

Did your involvement in the BHPBSEA inspire you to do more in the area of science or engineering?

On a scale of 1 (not at all) or 5 (very worthwhile), how worthwhile was the BHPBSEA experience for you?

Final comments

INTERVIEW QUESTIONS

Opening statement – thank you for agreeing to be interviewed for the evaluation of the BHP Billiton Science and Engineering Awards. Did you get a chance to read the information sheet that was emailed to you?

NO – please allow me to give you an overview of the project (please shorten the current Information Sheet and provide them an outline of what is going to be covered, how the data will be used and their ability to withdraw)

YES – Great, then do I have you consent to participate as well as audio record this interview?

Becoming involved

- How did you become involved in the BHP Billiton awards?
- Who encouraged you to do the investigation and enter the competition? (prompt – someone at school or outside your school environment?)
- Was it a school project that was nominated for an award?
- How many times have you entered the BHP Billiton awards? (probe for what year(s) they entered)

Description of the investigation

- Can you tell me about your experimental investigation?
- What did you find out from doing your investigation?

Description of the experience (investigation)

- What methods of science or engineering did you use in your investigation?
- After your investigation experience, do you think this is how scientists or engineers work?
- Did anyone help you with your experimental investigation? How?

Evaluation of the experience (investigation & competition)

- Did you enjoy the experience of completing the investigation? Taking part in the competition? Being an award winner?
- What did you learn about science or engineering from doing the investigation?
- What did you learn most from the experience?
- To what extent has your involvement in the competition improved your confidence in talking about science or engineering with other people? (prompt - consider the report, presentations, meeting other people)
- In what way does the science you experienced through the science and engineering competition compare to the science you do in school?

Effect of the experience

- Will you choose some science or engineering subjects in Years 11 and 12? (might need to adjust if they have left school)
- Has your involvement in the BHP Billiton awards contributed to this choice?
- What do want to do after you leave school? (once again, adjust if they have already left school)
- Has this been influenced by your experience of science or engineering through the Award scheme?
- In what ways has the experience of the competition influenced your attitude towards science or engineering?
    - Do you think of science or engineering any differently because of it?
    - Would you feel the same about science or engineering if you had got an award/not got an award?

Award – improvements and retention

- Would you have any areas that could improve the Awards?
- What would you like to see kept in regards to the awards?

Appendix C: Teacher online survey and interview questions

ONLINE SURVEY QUESTIONS

Evaluation information and Informed consent

Demographics (gender, age, # of years teaching, state)

Participation: School/teacher factors

- I have a history of encouraging students to enter science research competitions.
- My school has a history of encouraging students to enter science research competitions.
- Participation in science research competitions is something for students with special interests only.
- Participation in science research competitions is something for everyone.
- To a large extent, most other school staff are or have been involved in science or engineering competitions

Would you please describe your involvement with students who have entered science research competitions?

What is the level of awareness of teachers and students of the BHP Billiton awards?

Your motivation

What motivates you to take part in the BHPBSEA?

What would you say are the main barriers to teachers taking part in the BHPBSEA?

Participation: Student factors

- What motivates the students to enter science research competitions?
- What sort of students have enjoyed participating in these competitions?
- Is it always the same ones who enjoy science classes?

Impact on students' understandings and attitudes

What do you see as the outcomes for students in participating in science research competitions?

To what extent does participation in science and engineering competitions impacts on students':

- investigative skills
- appreciation of the nature of science
- communication skills
- engagement with science
- views of school science and science more generally

What aspects of the participation most significantly on impacts the students':

- doing the research project itself
- reporting of the project
- participating in an across-schools competition
- achieving success in the competition
- participating in the BHP Billiton camp (where applicable)

Impact on science enrolments

What evidence is there that participation in science research competitions impacts on enrolment patterns in school science, students' career intentions in relation to science, or numbers of students enrolling in science related tertiary courses?

Impact on curriculum and pedagogy

Do the science research competitions relate to the school's science curriculum? How?

In what ways has involvement with student research competitions impacted on your:

- own or other teachers' pedagogy and assessment practices more generally?
- own and other teachers' attitude towards open ended science investigations?
- perceptions within schools concerning the value of such activities?

Attitudes towards open ended science investigations

Have you used open-ended science investigations in your classroom teaching? Yes/No

If yes:

How many years have you used open-ended science investigations in your classroom?

What school level / grades have you used open-ended science investigations?

Does your whole school use open-ended science investigations? Yes / No

Can you please estimate the number of hours of professional development you have undertaken to gain teaching skills for open-ended science investigations?

From the list below, please identify what form of professional development you have undertaken for open-ended science investigations:

- None
- Train-the-trainer program
- Whole school face-to-face workshop
- Workshops with trainer (not whole school)
- Do-it-yourself programs (video or online)
- Satellite program
- Other (please expand on your answer)

Please rate, on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which you agree with the following statements about open-ended science investigations:

- Is a good source of activities
- Gets boring after a few years
- Increased my confidence to teach science
- Promotes skill and concept development across the whole class
- Helped me to learn science
- Kids love it
- Requires a lot of time for collecting information and resources
- Does not meet the requirements of the syllabus
- Is too difficult for poor readers
- Provides a common language for communication about science
- Is a good approach for a teacher who lacks experience in science

- Makes assessment difficult
- Professional development opportunities are inadequate

If no:

Please rate, on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which you agree with the following reasons for not using open-ended science investigations in your classroom:

- I have never hear of it
- It is too expensive
- My school elected not to use this approach
- I prefer to use other approaches
- It does not meet the requirements of the syllabus
- Other (please expand on your answer)

Worthwhileness of science and engineering investigation initiatives

Please rate, on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which you agree that science and engineering investigation initiatives providing students with the following:

- Motivation and enjoyment of science
- Developing positive attitudes towards themselves
- Stimulating curiosity and creativity
- Conceptual development
- Developing investigation and problem-solving skills
- Developing techniques and manipulative skills associated with using scientific or technical equipment
- Providing concrete experiences of a scientist or engineer
- Developing positive attitudes towards learning as a lifelong process
- Experiencing and developing an understanding of the nature and practice of science or engineering
- Learning to work autonomously
- Learning to work cooperatively
- Language development
- Developing positive attitudes towards and science and technology

Impact on you

Has the BHPBSEA had an impact on you? Yes/No

Areas for improvement

Final comments

INTERVIEW QUESTIONS

Opening statement – thank you for agreeing to be interviewed for the evaluation of the BHP Billiton Science and Engineering Awards. Did you get a chance to read the information sheet that was emailed to you?

NO – please allow me to give you an overview of the project (please shorten the current Information Sheet and provide them an outline of what is going to be covered, how the data will be used and their ability to withdraw)

YES – Great, then do I have you consent to participate as well as audio record this interview?

Participation: School/teacher factors

- Do you and /or your school have a history of encouraging students to enter science research competitions?

- Is participation in science research competitions seen as something for students with special interests and abilities or for a larger pool of students?
- Would you please describe your involvement with students who have entered science research competitions?
- What is the extent to which others on the school staff are or have been involved?

Participation: Student factors

- What motivates the students to enter science research competitions?
- What sort of students have enjoyed participating in these competitions? Is it always the same ones who enjoy science classes?

Impact on students' understandings and attitudes

- What do you see as the outcomes for students in participating in science research competitions?
- What evidence is there that participation in science research competitions impacts on:
    - students' investigative skills?
    - students' appreciation of the nature of science?
    - students' communication skills?
    - students' engagement with science?
    - students' views of school science and science more generally?
- What aspects of the participation impact most significantly on students:
    - students' investigative skills?
    - students' appreciation of the nature of science?
    - students' communication skills?
    - students' engagement with science?
    - students' views of school science and science more generally?
- What aspects of the participation impact most significantly on students:
    - doing the research project itself
    - reporting of the project
    - participating in an across-schools competition
    - achieving success in the competition
    - participating in the BHP camp (where applicable)
    - or some other aspect of it?

Impact on curriculum and pedagogy

- Do the science research competitions relate to the school's science curriculum? How?
- In what ways has involvement with student research competitions impacted on:
    - your own or other teachers' pedagogy and assessment practices more generally?
    - your own and other teachers' attitude towards open ended science investigations?
    - perceptions within schools concerning the value of such activities?

Impact on science enrolments

- What evidence is there that participation in science research competitions impacts on enrolment patterns in school science, students' career intentions in relation to science, or numbers of students enrolling in science related tertiary courses?

(Request for secondary data sources)

Awareness of Awards

- What is the level of awareness of teachers and students of the BHP Billiton awards?

Other

- What else would you like to say about this topic?

ADD TO LIST OF QUESTIONS TO ASK - Prize winning teachers

Nomination

- Who nominated you for this award?
- Why were you nominated?
- What special things have you done to promote science education in your school, and the community and in science education?
- What drives you to do this work? What do you think are the benefits for students?
- As an award winner you would have had the opportunity to attend the BHP Billiton Science Awards Presentation Day in Melbourne. Did you attend this event?
- Can you describe the conference and the experience?
- What impact has it had on your teaching?
- What were the best aspects of this event? Any problems or suggestions for improvement?

For National Winners Only (2012-15)

- As part of your award you had the opportunity to attend an overseas ISEF conference. Did you take this opportunity? Where did you go?
- Can you describe the conference and the experience?
- How has it impacted on your teaching?
- Has it changed your view of school science?
- How many students did you accompany?
- What were the best aspects of this event? Were there any issues for you? Any suggestions for improvement?

Characteristics of the Teachers Award

- What do you see as the best aspect of this award scheme?
- What do you see as problem aspect of this award scheme?

Impact of being an Award Winner

- How has receiving a Teachers Award impacted on: your teaching? Your career?
- How has the Teachers Award been acknowledged or recognised by colleagues, school, profession?
- Are you still involved in the open-ended investigations at your school? How?
- What have you learnt from your experience as a recipient of the Teachers Award?
- Have you implemented changes to the way science is taught at your school as a result of your experiences associated with receiving the teacher award?

Colleagues and School

- How did your school and colleagues impact on your receiving the award?
- Do you and /or your school have a history of encouraging students to enter science research competitions?
- Would you please describe your involvement with students who have entered science research competitions?

- What is the extent to which others on the school staff are or have been involved?
- What motivates the students to enter science research competitions?
- What sort of children have enjoyed participating in these competitions? Is it always the same ones who enjoy science classes?

Impact on students' understandings and attitudes

- What do you see as the outcomes for students in participating in science research competitions?
- What evidence is there that participation in science research competitions impacts on students' investigative skills and their appreciation of the nature of science?

(Request for secondary data sources)

- What evidence is there that participation in science research competition impacts on the students' communication skills?

(Request for secondary data sources)

- What evidence is there that participation in science research competitions impacts on students' engagement with science?

(Request for secondary data sources)

- What evidence is there that participation in science research competitions impacts on students' views of school science and science more generally?

(Request for secondary data sources)

Impact on curriculum and pedagogy

- Do the science research competitions relate to the school's science curriculum? How?
- Has involvement with student research competitions impacted on your own or other teachers' pedagogy and assessment practices more generally?
- Has involvement with science research competitions impacted on your and other teachers' attitude towards open ended science investigations?
- Has involvement with science research competition initiatives impacted on perceptions within schools concerning the value of such activities?

Impact on enrolments

- What evidence is there that participation in science research competitions impacts on enrolment patterns in school science?

(Request for secondary data sources)

- What evidence is there that participation in science research competitions impacts on numbers of students enrolling in science related tertiary courses?

(Request for secondary data sources)

- What evidence is there that participation in science research competitions impacts on students' career intentions in relation to science?

Awareness of Awards

- What is the level of awareness of teachers and students of the BHP Billiton awards?

Other

- What else would you like to say about this subject?

Appendix D: Judges online survey and interview questions

ONLINE SURVEY QUESTIONS

Evaluation information and Informed consent

Demographics (gender, age, # of years teaching, state)

This first section is to ask about your experience and opinions on the judging of the **teacher** Awards.

Description and reflections of the judging experience

What key things were you looking for in teachers when making your judgements?

How much do you agree that the following points should measure towards teacher quality?

- professional knowledge – supports and extends students
- professional practice- effectiveness, innovation(cutting edge, student competencies)
- professional attributes – collegiality, mentoring

Teacher practices

Can you describe the quality of the teacher practices you came across in judging the awards?

Do you think the awards attract and reward genuinely high quality science teaching practices?

From your discussions with or knowledge otherwise of the teachers, what is your sense of the impact the Science Competition has had on them professionally? Please rate the following in a scale of 1 to 5.

- Pedagogy and assessment practices
- Attitude towards open ended science investigations?
- Perceptions within schools concerning the value of such activities
- Self esteem or encouragement to pursue these types of activities

This next section is to ask about your experience and opinions on the judging of the **student** Awards.

Reflections on student submissions

On a scale of 1 to 5, how important would you rate the following aspects of student submissions and experiences of the Award scheme:

- Quality of the science that students display in these projects
- Level of innovation or creativity or science investigative skills that are displayed
- Improvement in science skills or understanding that may have been a result of the awards
- Improvement/confidence in communicating science ideas
- Student understanding of the nature of science
- Student engagement with science
- Attitudes to science
- Effects on their aspirations to continue with science, or more generally on enrolment patterns (secondary or tertiary science)

Insights from talking with students

When talking with students, do they mention whether this type of science is unusual in their school, or if it has caused any changes to their teachers' practices?

When talking with students, do they mention perceptions within schools concerning the value of science competitions?

Do the students mention other aspects of the science competition not mentioned already?(e.g. prizes, esteem, international aspects)?

Are the students aware of the nature (size, importance) of the BHP Billiton Science & Engineering Awards?

Overall question

How did the experience of acting as a judge impact on you personally or professionally?

Do you see any areas for improvement for the BHPBSEA?

Final comments

INTERVIEW QUESTIONS

Opening statement – thank you for agreeing to be interviewed for the evaluation of the BHP Billiton Science and Engineering Awards. Did you get a chance to read the information sheet that was emailed to you?

NO – please allow me to give you an overview of the project (please shorten the current Information Sheet and provide them an outline of what is going to be covered, how the data will be used and their ability to withdraw)

YES – Great, then do I have you consent to participate as well as audio record this interview?

FIRSTLY, CAN I PLEASE ASK YOU IF YOU WERE A JUDGE FOR TEACHERS, STUDENTS OR BOTH?

Judging Teacher Awards

Description of the experience

- Could you please describe your experience of being involved in the BHP Billiton award scheme?
- How did the experience of acting as a judge impact on you personally or professionally?
- Would you please describe your involvement with teachers nominated for the awards, who have students entered into the science research competitions?

Reflections on judging

- What key things were you looking for in teachers when making your judgements?
- How did you measure the quality of the teacher applicants?
    - professional knowledge – supports and extends students
    - professional practice- effectiveness, innovation(cutting edge, student competencies)
    - professional attributes – collegiality, mentoring
- Can you give representative examples of each of these?
- What weighting is attributed to each of the selection criteria on the teacher's application?

Teacher practices

- Can you talk about the quality of the teacher practices you came across in judging the awards?
- Do you think the awards attract and reward genuinely high quality science teaching practices?
- From your discussions with or knowledge otherwise of the teachers, what is your sense of what impact the Science Competition has had on them professionally – relating to a change?
    - pedagogy and assessment practices?
    - attitude towards open ended science investigations?
    - perceptions within schools concerning the value of such activities?
    - self esteem or encouragement to pursue these types of activities?
- Can you describe this further, possibly giving examples of how the awards have acted as a stimulus to the teaching of science open ended investigations or inquiry based pedagogies more generally?

Judging Student Awards

Description of the experience

- Could you please describe your experience of being involved in the BHP Billiton award scheme?

- What has been your involvement with students who have entered into the science research competitions?
- In judging the entries or discussing the projects with students, can you gain a sense of how the participation in the Science competition has impacted on them?
- Can you provide any examples that might illustrate or provide insight into the:
    - quality of the science that students display in these projects
    - level of innovation or creativity or science investigative skills that are displayed
    - improvement in science skills or understanding that may have been a result of the awards
    - improvement/confidence in communicating science ideas
    - student understanding of the nature of science
    - student engagement with science
    - attitudes to science
    - effects on their aspirations to continue with science, or more generally on enrolment patterns (secondary or tertiary science)
- The types of students that are involved in these awards – are they science enthusiasts?
- Are they necessarily strong students academically (not sure how they could make this judgment)?
- Was it evident they got a lot of support from school or from home?

Teacher practices

- When talking with students, do they mention whether this type of science is unusual in their school, or if it has caused any changes to their teachers' practices?
    - pedagogy and assessment practices
    - attitude towards open ended science investigations

Value of science competitions

- When talking with students, do they mention perceptions within schools concerning the value of science competitions?
- Do the students mention other aspects of the science competition not mentioned already?(e.g. prizes, esteem, international aspects)?

Awareness of BHPBSEA

- Are the students aware of the nature (size, importance) of the BHP Billiton Science Awards?

Appendix E: Key Stakeholder online survey and interview questions

ONLINE SURVEY QUESTIONS

Evaluation information and Informed consent

Demographics (gender, age, # of years involved with Science and Engineering Awards – specifically BHPBSEA, state)

Adding engineering to Awards

What influence did you see to your State Science Awards by BHP Billiton adding engineering top their Awards scheme?

Attitudes towards open ended science investigations

Please rate, on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which you agree with the following statements about open-ended science investigations:

- Is a good source of activities
- Gets boring after a few years
- Increases teacher confidence to teach science
- Promotes skill and concept development
- Helps teachers to learn science
- Students love it
- Requires a lot of time for collecting information and resources
- Does not meet the requirements of the Australian curriculum
- Is too difficult for weaker students
- Provides a common language for communication about science
- Is a good approach for a teacher who lacks experience in science
- Makes assessment difficult
- Professional development opportunities in this field are inadequate

Worthwhileness of science research investigation initiatives

Please rate, on a scale of 1 (strongly disagree) to 5 (strongly agree), the extent to which you agree that science and engineering investigation initiatives providing students with the following:

- Motivation and enjoyment of science
- Developing positive attitudes towards themselves
- Stimulating curiosity and creativity
- Conceptual development
- Developing investigation and problem-solving skills
- Developing techniques and manipulative skills associated with using scientific or technical equipment
- Providing concrete experiences of a scientist or engineer
- Developing positive attitudes towards learning as a lifelong process
- Experiencing and developing an understanding of the nature and practice of science or engineering
- Learning to work autonomously
- Learning to work cooperatively
- Language development

- Developing positive attitudes towards and science and technology

Feedback

What aspects of the Award do you think are good and should be retained?

Do you have any ideas about how BHPBSEA could be improved?

Final comments

INTERVIEW QUESTIONS

Opening statement – thank you for agreeing to be interviewed for the evaluation of the BHP Billiton Science and Engineering Awards. Did you get a chance to read the information sheet that was emailed to you?

NO – please allow me to give you an overview of the project (please shorten the current Information Sheet and provide them an outline of what is going to be covered, how the data will be used and their ability to withdraw)

YES – Great, then do I have you consent to participate as well as audio record this interview?

Adding engineering to Awards

What influence did you see to your State Science Awards by BHP Billiton adding engineering top your Awards scheme?

Attitudes towards open ended science investigations

What is your opinion ion the use of open-ended science investigations in classrooms and outside schools?

Do you think teachers using an open-ended science investigation approach improves their confidence to teach science?

Is open-ended science investigations best used by experienced or new teachers?

Do you know of any Professional development opportunities in open-ended science investigation approach? If yes, are inadequate?

Worthwhileness of science research investigation initiatives

What do you believe science and engineering investigation initiatives providing students?

Prompts:

- Motivation and enjoyment of science
- Developing positive attitudes towards themselves
- Stimulating curiosity and creativity
- Conceptual development
- Developing investigation and problem-solving skills
- Developing techniques and manipulative skills associated with using scientific or technical equipment
- Providing concrete experiences of a scientist or engineer
- Developing positive attitudes towards learning as a lifelong process
- Experiencing and developing an understanding of the nature and practice of science or engineering
- Learning to work autonomously
- Learning to work cooperatively
- Language development
- Developing positive attitudes towards and science and technology

What do you believe science and engineering investigation initiatives providing your organisation?

Feedback

What aspects of the Award do you think are good and should be retained?

Do you have any ideas about how BHPBSEA could be improved?

Final comments

Appendix F: Media analysis coding criteria

1. Article length –measured by word count.
2. Media source – identify where the article was published.
3. Focal topic – a short phrase summarising the article's main area of discussion.
4. The extent to which BHPBSEA is a focus of the article - classified into 3 levels - primary, secondary, or incidental/peripheral. Each level's classification was based on the following criteria:
    - Primary – the focal subject clearly relates to BHPBSEA.
    - Secondary – the article is primarily focused on a related topic with substantial reference to BHPBSEA. For example, the benefits of science competitions.
    - Peripheral – the article mentions BHPBSEA and competitions only in passing, perhaps once or twice.
5. Listing of the terminology used to describe or refer to the BHPBSEA.
6. A broad assessment of the extent to which the author explains or defines the BHPBSEA, broken into three levels - none, basic or detailed. Each level's classification was based on the following criteria:
    - None – the article only refers to the BHPBSEA through terms such as 'a science competition'.
    - Basic – the articles outlines the BHPBSEA briefly in 1-2 sentence(s).
    - Detailed – beyond the 'basic' outline, the author explains more of the technical and logistical aspects of the Award, including the types of investigations submitted, the submission and/or nomination processes, judging criterion and so on.
7. An assessment of the technical accuracy of the explanation made using three levels - limited, fair, accurate.
    - Limited – explanation is incomplete or inaccurate.
    - Fair – basic elements of the Award is present in the explanation.
    - Accurate – extended the technical outline with further explanation of one or more aspects of the Award.
8. The extent to which the media entry position is affirmative, balanced, negative or neutral toward the BHPBSEA.
    - Positive – the media focuses on affirmative arguments for the BHPBSEA or science competitions.
    - Negative – the media mainly discusses problems and criticisms of the BHPBSEA or science competitions.
    - Balanced – the media presents both viewpoints.
    - Neutral – the media is non-argumentative or is not concerned with identifying a position in relation to the BHPBSEA or science competitions in general, but is communicating factual information relating to the Award.
9. Finally, the key themes will be analysed in regards to the content of the media captured.