ENHANCING YEAR 9 PERFORMANCE AND ENGAGEMENT IN SCIENCE

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ABSTRACT

This paper presents findings from an action research project designed to enhance Year 9 student performance and engagement in science at a regional secondary school. The project was initiated in response to poor performance of Northern High's Year 9 cohort on the 2009 Queensland Comparable Assessment Task (QCAT). The incoming 2010 Year 9 cohort (N=148) was baseline tested and surveyed using items from the 2006 Programme for International Student Assessment (OECD, 2007) and the 2009 QCAT (QSA, 2009c). The mean test score for students was below a 50% pass mark (4.4/10; SD±2.0). Attitudes towards science were largely positive, with just under three fifths of students perceiving science to be very relevant to them. Regression analysis revealed that personal relevance of science explained 8.2% of the variance in test scores ($p<.0005$). In focus group interviews, students (n=12) reported little exposure to science in the primary school, variable interest in their secondary science education, and no science career aspirations. The Head of Department (HOD) identified the need for greater engagement with the science *ways of working* and criterion-based assessment, as presented in the Queensland Curriculum, Assessment and Reporting (QCAR) framework (QSA, 2007a), in the faculty's 2010 program. A marked improvement in performance on the 2010 QCAT suggests important links to the faculty's implementation of the QCAR framework, curriculum leadership provided by the HOD, and external support for curriculum reform through collaboration and data sharing with researchers.

Keywords: *secondary science education, scientific literacy, comparative science testing, action research*

LITERATURE REVIEW

A "language of crisis is being used by government, industry and educators" throughout the developed world (Tytler, 2007, p. 1) to describe declining participation in post-compulsory science, as well as resultant shortages of science teachers and science graduates, especially in the physical sciences (Tytler & Symington, 2006). In the report, *Europe needs more scientists* (European Communities (EC), 2004), a High Level Expert Group pointed to a more student centred, socially oriented, and intellectually engaging science pedagogy to promote interest and develop overall positive dispositions towards science learning in the compulsory years. The Group (EC, 2004) reiterated the broad purpose of science education as ensuring a foundation of scientific literacy for all children, alongside stimulating interest in science pathways.

Over several decades, there has been growing international agreement regarding the nature and importance of scientific literacy as an outcome of schooling (Goodrum, Hackling & Rennie, 2001). A scientifically literate person has the capacity:

> to be interested in and understand the world, to engage in the discourses of and about science, to be sceptical and questioning of claims made by others about scientific matters, to be able to identify questions and draw evidence-based conclusions, and to make informed decisions about the environment and personal health and well-being. (Goodrum et al., 2001, p. 15)

Comparative performance in scientific literacy is measured in the OECD's triennial Programme for International Student Assessment (PISA). The 2006 PISA (OECD, 2007) expanded its earlier definition involving knowledge and competency dimensions to include greater emphasis on students' understanding of science as a form of human inquiry and endeavour, and attitudes toward science, given the latter's "important role in students' decisions to develop their science knowledge further, pursue careers in science, and use scientific concepts and methods productively through their lives" (p. 39). Findings from PISA 2006 (OECD, 2007) indicated that students who demonstrated the requisite knowledge and competencies to pursue more advanced studies in science tended not to report science career aspirations unless they also valued or enjoyed science.

Calls for a "significant re-imagining of science education" (Tytler, 2007, p. 1) emerged from the 2006 Australian Council for Educational Research conference, *Boosting Science Learning*. An associated review challenged "the proposition of a non-negotiable and structured canon of abstract concepts as the defining feature of science as an enterprise, and the appropriate major focus for school science" (Tytler, 2007, pp. 5 & 12). In the shaping of an Australian national science curriculum, "the process of building scientific knowledge through inquiry, observation, and gathering of evidence" was recognised "as important as the knowledge itself" (National Curriculum Board, 2008, p. 1). Similarly, emphasis in the Queensland science *essentials learnings* (Queensland Studies Authority, 2007a) is on science *ways of working*, alongside *knowledge and understanding*. Both domains are assessed in Queensland Comparable Assessment Tasks (QCATs), which according to the Queensland Studies Authority (QSA) (2009b) are not examinations or tests but "authentic, performance-based assessments" (p. 3). The QCATs, administered annually to Years 4, 6 and 9 Queensland students in English, mathematics and science, draw upon what are meant to meaningful contexts in order to engage students in problem solving, critical thinking, and reasoning (QSA, 2009b). Teachers are provided with a *Guide to making judgements* and sample student responses across an A-E standards continuum to promote consistency of judgement (QSA, 2009b).

RESEARCH BACKGROUND

This action research project was initiated in response to poor QCAT performance of the Year 9 cohort at Northern High, a medium-sized secondary school in regional Queensland. Eighty-six per cent of Northern High's Year 9 cohort received a D or E grade on the 2009 science QCAT, with E representing the most limited performance on the A-E continuum. This was well below the average performance across three regions in the 2008 extended science QCAT trial wherein about 50% of students achieved at a D or E standard (QSA, 2009a, p. 30). In the report associated with that trial (QSA, 2009a), it was speculated that poor performance may have reflected a combination of issues including "lack of student engagement, unfamiliarity with the style of assessment, lack of prior engagement with targeted Essential Learnings, difficulty in making judgments, and literacy demands" (p. 30). The action research project was framed in a meeting between Northern High's science Head of Department (HOD) and James Cook University (JCU) researchers with the broad aim of enhancing Year 9 scientific literacy and ultimately 2010 QCAT performance through an increased and explicit pedagogical focus on the *ways of working*, as emphasised in the Queensland Curriculum, Assessment and Reporting (QCAR) framework (QSA, 2007a). The HOD had been acting in the position since the start of 2009, and up to that point Northern High's science faculty had not engaged with the QCAR framework, which had been variably taken up in Queensland schools from 2008 onwards. This paper largely focuses on aspects of data collection, analysis, and sharing in the initial phase of the action research. To a lesser extent, it reports (via data emanating from an interview with the HOD) on some of the key actions undertaken in the first action cycle by faculty staff, and presents 2010 QCAT science performance results as one measure of their success. While researchers collaborated individually with the HOD and staff as a whole, time constraints have thus far prevented researchers working alongside teachers to document and reflect upon changes to individual teacher practice, as initially envisaged in the scope of the project. This gap provides immediate research direction. Overall, the project is intended to serve as a pilot for a larger study involving a number of secondary schools and transfer of action research methodologies and classroom pedagogical strategies.

RESEARCH DESIGN

Action research cycle

Action research methodology includes cyclic, collaborative, interventionist, and practical aspects that suggest it for small scale education research projects seeking to improve professional practice (Koshy, 2010). The action research cycle typically involves four phases of inquiry: (1) identifying a problem, (2) collecting and interpreting data, (3) planning and implementing actions, and (4) collecting data and reflecting upon findings (Ferrance, 2000). This methodology is suited to classroom situations and identified by the Queensland College of Teachers (2010) as one potential source of ongoing teacher professional development.

For this research project, ethics approval was obtained from the university and Education Queensland, with consent forms being signed by Northern High's principal and the science HOD. The first action undertaken in the project was planning for and implementing a two week unit, which served as an orientation to the *ways of working* for the incoming Year 9 cohort (N=148). At the end of this unit, all students were tested and surveyed. In addition, focus group interviews (n=12) were conducted some time afterward. At an early February faculty meeting, the researchers presented action research methodology to teachers. At a second meeting in early March, the researchers reported on baseline test performance results. In a third meeting in early May, researchers presented findings from the student focus group interviews and the regression analysis, identifying attitudinal predictors of students' test performance. Test, survey and interview findings broadly informed actions. Within the first action research cycle, the science team refined aspects of Chemistry and Biology units with greater incorporation of the *ways of working* and criterion-based assessment design. In mid September, researchers conducted an interview with the HOD to reflect on changes made within the first action cycle. Timing of this interview coincided with teacher marking of the 2010 science QCAT. In early October, the science HOD shared key school documents, including Year 9 unit plans, and the 2010 QCAT results with researchers.

Baseline test instrument

The baseline test examined capacity in a subset of the science *ways of working*, which were identified on the front cover of the instrument for students' reference. Constraints on the choice and quantity of test items included: 30 minutes of class time for administering of the test; a level of difficulty comparable to the 2009 QCAT (including consideration of literacy requirements); and limited time for teacher marking. The test instrument contained four contexts comprising a total of 10 questions. Eight questions were multiple choice, with four questions requiring single responses and four, responses to multiple parts. Two questions required both a multiple choice answer and an explanation. The contexts involved climate change, sunscreens, clothes, and the Grand Canyon. The climate change context was chosen from the 2009 science QCAT (QSA, 2009c). Four new questions were written for this context in line with the constraints identified previously. Questions for the other contexts were sourced from the 2006 PISA (OECD, 2007) instrument. In addition to seven to ten sentences of written information for all contexts, the climate change context featured data displayed in graphs; the sunscreens context provided diagrams of experimental results; and the Grand Canyon context contained an annotated picture.

Four questions in the baseline test instrument were of a proficiency level 2 or 3; five questions, of a proficiency level 4; and one question, a proficiency level 5. Questions sourced from PISA 2006 (OECD 2007) had a predetermined proficiency level. For the balance of questions, researchers made an assessment via the summary descriptions of the proficiency levels provided by PISA 2006 (OECD, 2007). For example, at proficiency level 3, students can "draw a conclusion from an uncomplicated or simple pattern in a dataset" (OECD, 2007, 102) whereas, at level 4, students can:

> interpret a dataset expressed in a number of formats, such as tabular, graphic and diagrammatic, by summarising the data and explaining relevant patterns. They can use the data to draw relevant conclusions. Students can also determine whether the data support assertions about a phenomenon. (OECD, 2007, p. 101)

The test was administered in regular school time and marked by science staff with reference to a researcher-supplied answer sheet. The student answer sheets were de-identified and re-marked by researchers on the basis of questions entirely correct or incorrect, in alignment with PISA processes (OECD, 2007). All quantitative student data were entered into PASW Statistics 18.0 (SPSS Statistics) by one researcher and verified by another.

Attitudinal survey

In addition to assessment of performance, students were also surveyed in terms of their attitudes towards science. The attitudinal survey was presented as Part B of the baseline test, with five minutes time allocation for its completion. It comprised 12 items, which were selected from the four broad areas of the PISA 2006 (OECD, 2007) attitudinal questionnaire: *support for scientific enquiry*, *self-belief as science learners*, *interest in science*, and *responsibility towards resources and environments* (OECD, 2007, p. 122). For each of the attitudinal statements, students were asked to express their level of agreement on a four-point Likert scale, using one of the following responses: 'strongly agree', 'agree', 'disagree', or 'strongly disagree'. As in PISA 2006 (OECD, 2007), students who reported that they 'strongly agreed' or 'agreed' with a statement were considered to be supportive of it. Thus, attitudinal findings for the Year 9 cohort of this study are able to be compared with those of the 15-year old Australian and OECD participants of PISA 2006 (OECD).

Attitudinal predictors of test performance

Standard multiple regression analysis was undertaken in PASW Statistics 18.0 (SPSS Statistics) to identify attitudinal variables that were predictors of students' test performance. All of the attitudinal variables were entered into the regression equation simultaneously and those that were weakly correlated with test performance were removed from the model (Pallant, 2007). According to Tabachnick and Fidell (2007, p. 122), regression seeks "to identify the fewest independent variables necessary to predict a dependent variable, where each independent variable predicts a substantial and independent segment of the variability in the dependent variable." The final model was built with two independent variables that did not have a high bivariate correlation. The standardised beta coefficients were used to compare the unique contribution of each of the independent variables (Pallant). Tests determined the statistical significance of the results, in terms of both the two independent variables and the model itself. Tabachnick and Fidell (2007) provided a formula for calculating sample size requirements: $N \geq 50 + 8m$ (where m = number of independent variables). The desired number of cases when applying this formula is ≥ 66. Our final model drew upon 134 cases: 13 cases had missing data and one outlier was detected in the scatterplot and identified through the Casewise Diagnostics function. The latter was deleted from the dataset given the sensitivity of multiple regression to such cases (Tabachnick & Fidell, 2007).

Focus group interviews
Two focus group interviews involving 12 participants (seven males and five females) were held in April 2010. These students had returned informed consent forms that had been signed by their parents. The interviews were of 60 minutes duration and conducted in a classroom within school hours. The interview schedule comprised questions pertaining to the nature and format of the baseline test, students' formal science education both in the primary and secondary school, and students' career aspirations. Considerable time had elapsed between the baseline test and the focus group interviews. When Fensham (1998) investigated Year 12 students' perceptions of the relevance of the science topics included in the TIMSS achievement tests, interviewers were on hand to interview students immediately after the test. Nonetheless, a decision was made to pursue some questions pertaining to the baseline test after a participant teacher reported that students had complained about the amount of reading, which was required by the test. So, at the commencement of focus group interviews, students were given a copy of the baseline test, and each test question was reviewed and discussed as a group before the interviewer asked the schedule of questions. Focus group interviews were recorded by audiotape and transcribed for analysis. Transcripts were read exhaustively to identify key themes.

RESULTS AND DISCUSSION

Baseline test performance
The mean baseline test result for Northern High's students (N = 148) was 4.4 out of 10 (SD±2.0); the median, four out of 10. The mode test score was five out of 10, with one-fifth of students achieving this result. Only 27% of students attained a result greater than or equal to six out of 10. While the majority of Northern High's students attained level 2 and 3 questions, Table 1 shows noticeably lower overall performance on proficiency level 4 and 5 questions. With the exception of question 3, overall cohort performance can be seen to decline with an increase in the proficiency level of the question.

Table 1 Comparison of student performance on test questions between the 2010 Northern High and the 2006 PISA tests

	Question structure	PISA proficiency	Percentage of students who answered correctly	
			Northern High 2010	OECD 2006[a]
Question 1	Two part multiple choice	Level 2	84	
Question 10	Single multiple choice	Level 2	68	68
Question 9	Two part multiple choice	Level 3	55	61
Question 3	Four part multiple choice	Level 4	54	
Question 2	Single multiple choice	Level 3	51	
Question 6	Single multiple choice	Level 4	45	58
Question 8	Four part multiple choice	Level 4	29	47
Question 5	Single multiple choice	Level 4	25	40
Question 7	Single multiple choice & written explanation	Level 4	18	27
Question 4	Single multiple choice & written explanation	Level 5	6	

[a] Source: OECD. (2007).

Table 1 reveals a noticeable gap in performance between Northern High's Year 9 students and OECD participants on level 4 questions. In Queensland, students in Year 9 typically turn 14 during that school year. Thus, the majority of Northern High's cohort was likely to 13 at the sitting of the baseline test. It is evident from Table 1 that 15-year old PISA participants were more strongly positioned to operate at a level 4 proficiency. Twenty-two percent of Northern High's students successfully answered at least one question requiring a written explanation; only 2% of students answered both questions successfully. In PISA 2006, Australian students demonstrated relative weakness in explaining phenomena scientifically in spite of strong overall test performance (OECD, 2007).

Attitudinal survey findings

In terms of attitudes towards science, Northern High's Year 9 students presented similarly to Australian and OECD 15-year old students who participated in PISA 2006. Table 2 shows that over 90% of Northern High students either 'strongly agreed' or 'agreed' that science plays an important role in society.

Table 2 Percentage of students who either 'strongly agreed' or 'agreed' with attitudinal statements among 2010 Northern High and 2006 PISA cohorts

	Northern High 2010	Australia PISA 2006[a]	OECD average 2006[a]
Support for scientific enquiry			
General value of science			
Science is valuable to society.	93	89	87
Advances in science and technology usually improve people's living conditions.	92	90	92
Personal value of science			
Science is very relevant to me.	59	55	57
I will use science in many ways when I am an adult.	*54*	*63*	*64*
Self-belief as science learners			
Self concept in science			
When I am being taught school science, I can understand the concepts very well.	66	60	59
Interest in science			
Importance of learning science			
It is important to do well in school science.	81	72	72
Instrumental motivation to learn science			
Studying school science is worthwhile for me because what I learn will improve my career prospects.	62	64	61
Enjoyment of science			
I am interested in learning about science.	62	61	63
I like reading about science.	32	43	50
Future-oriented motivation to learn science			
I would like to work in a career involving science.	31	39	37
Responsibility towards resources and environments [a]			
Level of concern for environmental issues			
I am concerned about environmental issues (e.g. forest clearing, increase in greenhouse gases, water shortages, extinction of plants and animals etc.).	83	75–92[b]	76–92[b]

[a] Source: OECD. (2007).

[b] Level of concern for nominated environmental issues: air pollution; extinction of plants and animals; clearing of forests for other land use; energy shortages; nuclear waste and water shortages.

Eighty percent of students believed it is important to do well in science. Two-thirds of students believed that when taught school science, they understand the concepts very well. Over 60% expressed a broad interest in science and, a similar proportion, the belief that studying science would improve career prospects. However, fewer students perceived science to be relevant to them and, similarly, that they will be able to use it in many ways when they are adults. Less than one-third liked reading about science. The lowest proportion expressed the desire to work in a career involving science. So too, only a minority of Australian and OECD students reported that they would like a career in science (Table 2). The Relevance of Science Education international comparative study (Sjøberg & Schreiner, 2005), incorporating the experience of countries outside of the PISA initiative, revealed large cross-national differences in terms of students' desire to become scientists, with extremely low mean scores for developed countries.

Attitudinal predictors of test performance

A final regression model to predict baseline test performance was built from two independent variables: 'science is very relevant to me' and 'when I am being taught school science, I can understand the concepts very well'. The other attitudinal variables (presented in Table 2) were not strongly correlated with the dependent variable. It can be seen from Table 3 that the final model explains 15.5% of the variance in students' baseline test performance (R^2=.155). The direction of the relationships suggests that students who perceived science to be relevant to them and had a positive self-concept performed better on the baseline test. Of these two variables, personal relevance makes the largest unique contribution (sr^2=.82) to explaining variance in test scores. While self-concept in science only approached significance (p=.065), personal value of science—and the overall regression model—was highly statistically significant (p<.0005). Results from PISA 2006 (OECD, 2007) revealed that, in 97% of participant OECD countries, students who reported a higher level of personal value of science performed better in the science assessment. In all OECD countries, there was a positive association between students' self concept in science and their performance.

Table 3 Standard multiple regression of personal value and self-concept of science on test performance

Independent Variables	Beta	Sig.	Unique contribution to variance (%)
Personal value of science			
Science is very relevant to me.	.307	<.0005	8.2
Self-concept in science			
When I am being taught school science, I can understand the concepts very well.	.160	.065	2.3
R^2 = .155 (unique variability = .105; shared variability = .050)			
Adjusted R^2 = .143			
p < .0005			
N = 134			

Focus group interviews

Baseline test

When asked if the baseline test was similar to school science tests, one student responded that what was different was "the way we had to answer – we were given a lot of information and you had to pick it for yourself." Another student explained that "there was like a whole three full paragraphs about the clothes" and, given the amount of required reading, "I often just guessed". The interviewer pointed out to students that the table on the first page of the test, which identified the processes to be utilised in each of questions, was located there to prepare students for test emphases other than simply factual recall. One student said, however, that in their test sitting they "only had a scan"; another concurred, "yes, it was like instructions, turn over the page, and the teacher said, 'That's done'."

Primary school science

Focus group interview participants had little recollection of substantive engagement with science in the primary school. One student spoke of a Year 7 experiment involving "waves in a bath"; two had looked at electric currents, one of whom pondered in the interview whether that was, in fact, science. One female student recollected an excursion wherein they visited water wells, however, she said that they didn't do "science-science" – rather it was "the environment". However, the majority of participants had no experiences to draw upon, with one saying, "I didn't even know what science was back then". Students' responses resonate with findings from a large-scale study (Rennie, Goodrum & Hackling, 2001) reporting an average of only 59 minutes per week of science in Australian primary schools, with considerable variation across schools. Rennie et al. (2001) identified teacher's lack of science background knowledge, inadequate resources, and an overcrowded curriculum as limiting factors in terms of delivery of primary school science.

Secondary school science
There was a range of responses to questions pertaining to participants' enjoyment and perceptions of relevance of secondary school science. One female student said that they were doing "a lot of theory" and that was "really boring". A male student elaborated:

> All we do is just copy stuff down and get told stuff. Every now and then we watch a video. It is not going to help me anywhere in life, like get a job.

One student thought enjoyment of science was dependent on the teacher, explaining that "everyone has different teaching methods" and science could be made interesting "if it is a really good teacher". Two students expressed enthusiasm for the practical component of their science program, with a third stating, "I really like the subject but what I want to do with my life, I don't think is going to be quite the same".

None of the participants held career aspirations in science, had a parent who was a scientist, or had parents who held expectations for their children in terms of performance in science beyond a general commitment to studies. According to Jenkins (2006), when investigating 'student interest' in science, researchers have tended to treat interest as a personal attribute of the student rather than as an outcome of science education. However, in a study of the uptake of high achieving Australian students in senior Physics and Chemistry, Lyons (2006b, p. 308) identified the "most cogent single force acting against the physical science courses" to be "the culture of school science itself". He found that for students to elect senior science they needed a strong self-concept and the family capital (including positive parental attitudes toward formal education and science) to counter the lack of intrinsic value of school science.

When asked what could add to their enjoyment of school science, one student argued, "I don't think it could be made more relevant – I think it's just a matter of learn it or not". Several students suggested a shift away from copying down notes from the board and more emphasis on practicals. One student said that demonstrations would be helpful – "instead of reading about it they can show us." Students also expressed the desire to engage in experiences "like hands-on scientists" – "like marine biologists, they go out and they get stuff". One student stated that they would like the opportunity to "look at questions and have to think for ourselves"; another concurred, "like research." In a recent South Australian study, Elliot and Page (2010) also reported on Year 9 students' desire to conduct their own investigations supported by an inquiry approach and "meaningful and contextual" experiments (p. 14) – that is, a hands-on as well as minds-on approach to science.

Staff meetings
At the March science faculty meeting, researchers reported on baseline test performance and attitudinal survey findings. Teachers communicated to researchers their sense that both the 2009 QCAT and the baseline test were too difficult for Year 9 students and asked whether this may be the new standard reflected in the national science curriculum. Teachers were surprised at the attitudinal survey findings as they felt there was a gap between students' largely positive attitudes to science reported in the survey and those demonstrated in their Year 9 classrooms.

At the May science faculty meeting, findings from regression analysis and focus group interviews were shared with teachers. Teachers were more willing to engage with discussion around ways to promote students' self-concept in science than considerations of how science could be potentially more relevant to their Year 9 students. Teachers said that not only were they constrained by the curriculum in planning for learning in science but that students' calls for more interesting contexts and less transmissive pedagogy may simply mean that students wanted a form of "edutainment". When it was reported to teachers that focus group findings had resonance in the literature, teachers responded that students may not be in the position to make informed judgements about what they should be taught in their school science courses.

Interview with and data forwarded by science HOD

Actions within the first cycle

Modifications to the Year 9 science program were planned with reference to the QCAR framework and findings from baseline data collection. The science program was altered in terms of curriculum and assessment. The science faculty continued to offer a Year 9 science program comprising units related to the four senior science subjects: Chemistry, Biology, Earth Science, and Physics. In the first action research cycle, units in Chemistry and Biology were reshaped to more strongly align with QCAR. Alongside content, *ways of working* were explicitly referred to in unit plans. The HOD indicated that this inclusion prompted teachers to directly address investigative skills development in their lessons. The HOD explained:

> Last year, if you spoke about student investigative skill development, staff would suggest that students learn those skills during the unit. However, the staff would not be able to clearly elucidate particular experiences the students were learning these skills in. Teachers assumed students acquired the skills throughout the unit rather than planning a series of experiences to explicitly teach the process of investigation.

Assessment was also modified, taking into greater consideration criterion-based aspects of assessment design. Chemistry exam test items were compared individually against QCAR science assessable element descriptors across the A-E standards continuum (QSA, 2007b). This process revealed that the existing distribution of questions heavily favoured knowledge and understanding and competencies within A and B standards descriptors. The test format was reworked to highlight the targeted assessable elements and standards, and coverage of questions was adjusted to allow a more even distribution across the continuum. As a result, cohort performance was enhanced and, according to the HOD, student self-concept in science was in turn promoted. Additionally, the HOD, having attended a 'literacy in the curriculum' professional development program, provided professional development for science staff pertaining to the design of assessment task exemplars. An exemplar was utilised for a Year 9 Chemistry science report task wherein the salient features, including key scientific terminology and desirable language elements, were colour coded for purposes of explicit teaching to students.

At the start of the second action research cycle, these findings were presented to staff and used as a rationale to reshape learning and assessment in Earth Science and Physics units. In all, the action research framework promoted greater sharing of teaching and assessment practices among faculty staff. Responsibility for redesign of aspects of the Year 9 science curriculum was allocated to different staff members who then were asked to present unit changes and teaching ideas and strategies to faculty staff prior to implementation.

2010 science QCAT results

Northern High's students undertook the QCAT within the second action research cycle. Table 4 presents QCAT results for 2010 and the year prior. According to the HOD, there was no notable difference in level of difficulty between QCATs. In 2009, 14% of students' work was assessed at a C standard as compared with 46% of work assessed at that standard or above in 2010. While just under one half of students achieved at an E standard in 2009, that proportion had dropped to well under one fifth of students in 2010. The marked improvement in performance on the 2010 QCAT suggests important links to the faculty's implementation of the QCAR framework, curriculum leadership provided by the HOD, and external support for curriculum reform through collaboration and data sharing with researchers.

Table 4 Comparison of Northern High student results for 2009 and 2010 science QCAT

Grade	2009		2010	
	Number of students (N=162)	Percentage of students (%)	Number of students (N=156)	Percentage of students (%)
A	0	0	5	3
B	0	0	17	11
C	23	14	50	32
D	61	38	57	37
E	78	48	27	17

CONCLUSION

This paper presents findings from one action research cycle employed by a faculty to enhance Year 9 performance in science. A limitation of action research methodology is that it can be difficult to generalise results from a specific context. However, the student participants in this study were found to be very similar in their attitude and exposure to science as their Australian peers. The students reported a lack of substantive engagement in science in the primary school, as well as secondary science lessons within which they were variably engaged. In spite of students' school science experiences and general lack of science career aspirations, they remained largely positive about science and its importance. Prior to the appointment of the current science HOD, the Northern High faculty had not introduced the *essential learnings* (QSA, 2007a) into science programs. Performance of students on Northern High's first science QCAT (2009), designed to test students' competencies as well as knowledge and understanding, was consequently poor. Findings pertaining to baseline test performance of the incoming 2010 cohort also indicated that students required much assistance with the *essential learnings* and QCAT results were likely to be similarly poor in 2010 if no action was undertaken. As part of engagement with the QCAR framework, faculty staff incorporated increased and explicit pedagogical emphasis on the *science ways of working* and assessment task requirements, as well as consideration of criterion-based assessment design features, in their Year 9 science program – actions that are likely reflected in the marked improvement in Northern High's QCAT performance in 2010. The role performed by the science HOD was crucial to the study. The HOD was primarily responsible for negotiating with researchers and leading curriculum reform by facilitating sessions in faculty meetings for review of planning and results. Researchers supported the reform agenda in the first action research cycle by collecting relevant data and sharing findings at a series of meetings. While researchers collaborated with the HOD and staff as a whole, time constraints prevented researchers working individually with teachers to document and reflect upon changes to individual teacher practice and this is where investment is next warranted.

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