quick**smart**

Annual Numeracy Program Report

2009

The SiMERR National Research Centre

The University of New England

ARMIDALE NSW

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1 *QuickSmart* in 2009

In 2009, the *QuickSmart* team at the University of New England received data from 1078 students who participated in *QuickSmart* Numeracy lessons and 508 average-achieving comparison peers. These students were drawn from eight clusters of schools from around Australia. Further data were also submitted for independent analysis to the Northern Territory (NT) Department of Education and Training by NT schools.

The analyses presented in this report provide information about students' performance on the Cognitive Aptitude Assessment System (CAAS) and on standardised test measures, specifically the Progressive Achievement Tests in Mathematics (ACER, 2009). Further investigation of the data provided in this report examines the results in terms of gender and for the participating Indigenous students.

2 Background

2.1 Purpose of *QuickSmart*

The prime purpose of the *QuickSmart* program is to reverse the trend of ongoing poor academic performance for students who have been struggling at school and who are caught in a cycle of continued failure. These targeted students experience significant and sustained difficulties in basic mathematics and/or literacy, and have a profile of low progress despite attempts to overcome their learning problems. Many such students have not drawn lasting benefits from other in-class and withdrawal instructional activities.

In addition, the *QuickSmart* professional learning program is designed for classroom teachers, special needs support teachers, and paraprofessionals to learn how to work with, and significantly improve, the learning outcomes in basic mathematics and literacy skills of under-achieving students in the middle years of schooling. The program features professional learning and support for working in a small class instructional setting with two students, using a specially constructed teaching program supported by extensive material and computer-based resources.

2.2 *QuickSmart* program description

The *QuickSmart* Numeracy and Literacy interventions were developed through the National Centre of Science, Information and Communication Technology and Mathematics Education for Rural and Regional Australia (SiMERR) at the University of New England, Armidale. The *QuickSmart* programs have been under development and continuous improvement since 2001.

The intervention is called *QuickSmart* to encourage students to become *quick* in their response speed and *smart* in their understanding and strategy use. In *QuickSmart*, the aim is to improve students' information retrieval times to levels that free working-memory capacity from an excessive focus on mundane or routine tasks. In this way, students are able to engage meaningfully with more demanding cognitive activities. In these interventions, automaticity is fostered; time, accuracy and understanding are incorporated as key dimensions of learning; and an emphasis is placed on ensuring maximum student on-task time. *QuickSmart* lessons develop learners' abilities to monitor their academic learning and set realistic goals for themselves.

3 Overall *QuickSmart* results

Two major sets of analyses quantify the benefits of the *QuickSmart* program. The first analysis examines data from speed and accuracy CAAS measures related to arithmetic operations that were collected at the beginning and end of the *QuickSmart* program. These results represent a direct measure of the work of *QuickSmart* instructors and reflect the primary focus of the *QuickSmart* lessons.

The second set of analyses concern the results of independent tests in mathematics. Most schools have utilised the PATM (Progressive Achievement Test Mathematics) test, a standardised test developed by the Australian Council for Education Research (ACER). The PATM is an independent test taken prior to commencement of *QuickSmart* and at the completion of the program. PATM provides information about how the knowledge, skills and attitudes developed in *QuickSmart* are used and how they transfer to other broad areas of mathematics.

The results from these analyses are reported below in separate sections and include analyses of the data by gender and for participating Indigenous students.

3.1 Results on the CAAS assessments

Four tests measured students' speed and accuracy both before *QuickSmart* began and at the end of the program. The tests were: (1) Addition facts; (2) Subtraction facts; (3) Multiplication facts; and (4) Division facts. These facts are shown below in reverse order as often the most revealing results are shown in the operations which are at first weakest, in this case division. Interpretation of results in some other operations (e.g., addition) can be impacted by a 'ceiling effect' as many students record strong results at pre-test which do not leave much room for improvement. The CAAS results recorded for Comparison students should also be interpreted with the knowledge that many of these students are limited in terms of growth by a ceiling effect.

Average results from all numeracy students are presented in Tables 1 to 4 below. A detailed discussion of Table 1 is provided for clarification purposes and as a model for understanding the results provided in Tables 2 to 4. Note that the *p*-values included in tables in this report represent the probability or likelihood that there is no difference between mean scores for pre-intervention and post-intervention results. If this value is less than 0.05 this difference is usually considered statistically significant. This means that there is a less than 5% probability that the result was obtained by chance. If the *p*-value is more than 0.05 the two means may still be importantly different, however, there is an increased possibility that chance factors influenced the result. In our analyses this sometimes happens when the number of students in the group is quite small (as is often the case for comparison students).

3.1.1 Combined CAAS Analysis

3.1.1.1 Division

Table 1: CAAS division - all students 2009

CAAS Operation	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	p	Effect size
Division QS (speed secs)	689	4.859	2.481	2.718	1.825	-2.141	<0.001*	-0.983
Division COMP (speed secs)	342	3.503	2.012	2.654	1.465	-0.849	<0.001*	-0.483
Division QS (accuracy %)	689	65.546	23.988	87.45	16.653	21.904	<0.001*	1.061
Division COMP (accuracy %)	342	84.042	15.636	91.03	10.074	6.988	<0.001*	0.531

QS Numeracy 2009 – CAAS Results

(division speed)   **(division accuracy)**
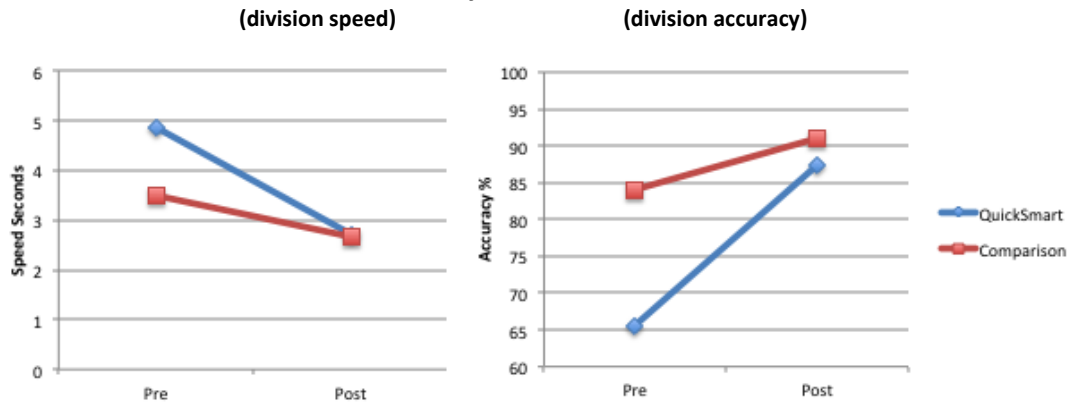
On the division test, there were paired data for 689 *QuickSmart* students and 342 comparison students. The desired criterion for response speed on the CAAS assessments is between 1 and 2 seconds as an indication of automaticity. The decrease in time for *QuickSmart* students is 2.141 seconds, which is a strong result. The effect size for this result is -0.983, which indicates substantial improvement. (Note the negative number means that the post-test time is lower than the pre-test time which is the desired pattern of improvement).

Effect size statistics can be understood based on the work of Hattie (Hattie, J. (2009). *Visible Learning: A synthesis of over 800 meta-analyses relating to achievement.* London: Routledge) such that:

- Effect sizes below 0.2 are considered poor, with an appropriate range of growth over an academic year for a student cohort established as within the range of 0.2 to 0.4;
- Effect size scores of 0.4 to 0.6 are considered strong;
- Effect sizes between 0.6 and 0.8 are considered very strong; and
- Effect size scores above 0.8 represent substantial improvement of the order of approximately three years' growth.

In terms of accuracy, the *QuickSmart* students' average scores have improved by nearly 22 percentage points, which is a very strong result. The effect size is 1.061, which again indicates substantial improvement for the *QuickSmart* group.

Table 1 shows that when compared to the scores of the comparison students *QuickSmart* students' scores indicate substantial improvement in terms of speed and accuracy in division. The diagrams illustrate the narrowing of the gap between the *QuickSmart* students and comparison students.

3.1.1.2 Multiplication

Table 2: CAAS multiplication - all students 2009

CAAS Operation	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	*p*	Effect size
Multiplication QS (speed secs)	815	4.546	2.736	2.609	1.734	-1.937	<0.001*	-0.846
Multiplication COMP (speed secs)	351	2.871	1.625	2.319	1.305	-0.552	<0.001*	-0.375
Multiplication QS (accuracy %)	815	74.722	21.243	90.024	13.765	15.302	<0.001*	0.855
Multiplication COMP (acc %)	351	89.234	11.163	93.038	8.925	3.804	<0.001*	0.376

QS Numeracy 2009 – CAAS Results

(multiplication speed)   **(multiplication accuracy)**
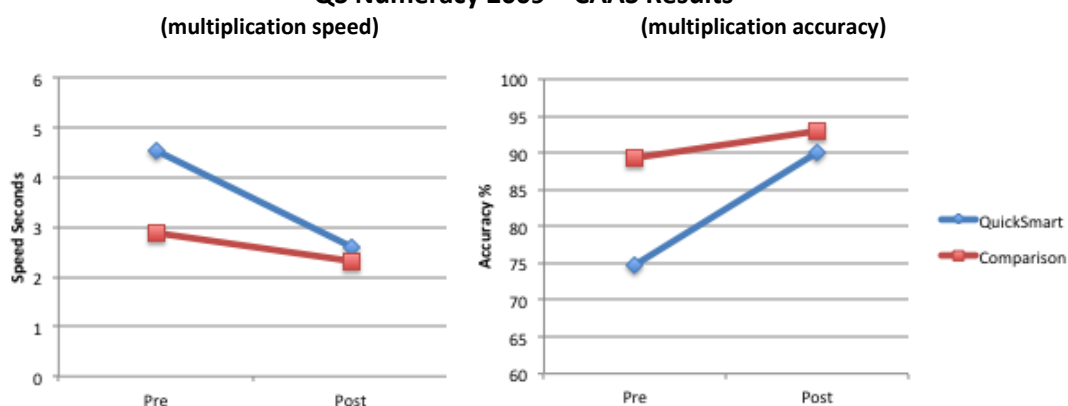
The results for multiplication indicate a significant improvement for the *QuickSmart* students. The diagrams illustrate the narrowing of the gap between the *QuickSmart* students and comparison students.

3.1.1.3 Subtraction

Table 3: CAAS subtraction - all students 2009

CAAS Operation	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	*p*	Effect size
Subtraction QS (speed secs)	841	3.672	1.863	2.27	1.193	-1.402	<0.001*	-0.896
Subtraction COMP (speed secs)	351	2.227	0.889	1.928	0.857	-0.299	<0.001*	-0.343
Subtraction QS (accuracy %)	841	87.926	11.711	95.807	6.967	7.881	<0.001*	0.818
Subtraction COMP (accuracy %)	351	95.321	5.972	96.742	4.815	1.421	<0.001*	0.262

QS Numeracy 2009 – CAAS Results

(subtraction speed)   **(subtraction accuracy)**
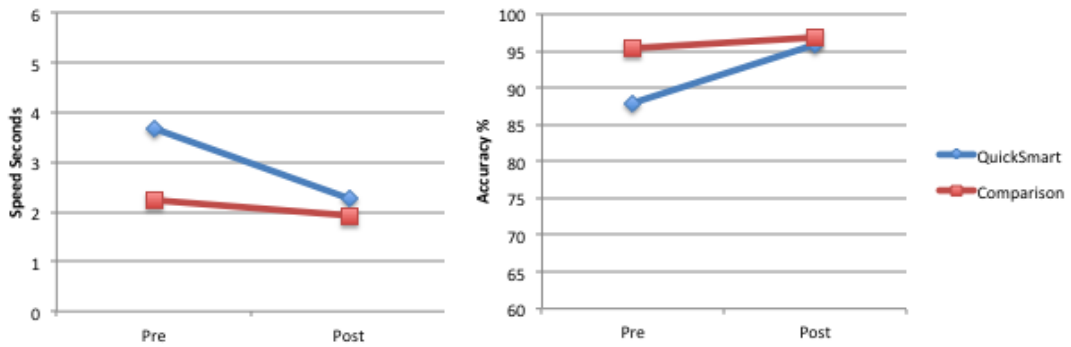
The results for subtraction indicate a very strong improvement for the *QuickSmart* students. The diagrams illustrate the narrowing of the gap between the *QuickSmart* students and comparison students.

3.1.1.4 Addition

Table 4: CAAS addition - all students 2009

CAAS Operation	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	*p*	Effect size
Addition *QS* (speed secs)	864	3.403	1.527	2.239	1.045	-1.163	<0.001*	-0.889
Addition COMP (speed secs)	353	2.197	0.787	1.936	0.769	-0.261	<0.001*	-0.336
Addition *QS* (accuracy %)	864	92.127	10.36	97.15	5.019	5.023	<0.001*	0.617
Addition COMP (accuracy %)	353	96.369	5.184	97.346	4.457	0.977	0.004*	0.202

QS Numeracy 2009 – CAAS Results

(addition speed)   **(addition accuracy)**

The results for addition indicate a strong improvement for the *QuickSmart* students. The diagrams illustrate the narrowing of the gap between the *QuickSmart* students and comparison students.

3.1.2 CAAS By Demographics
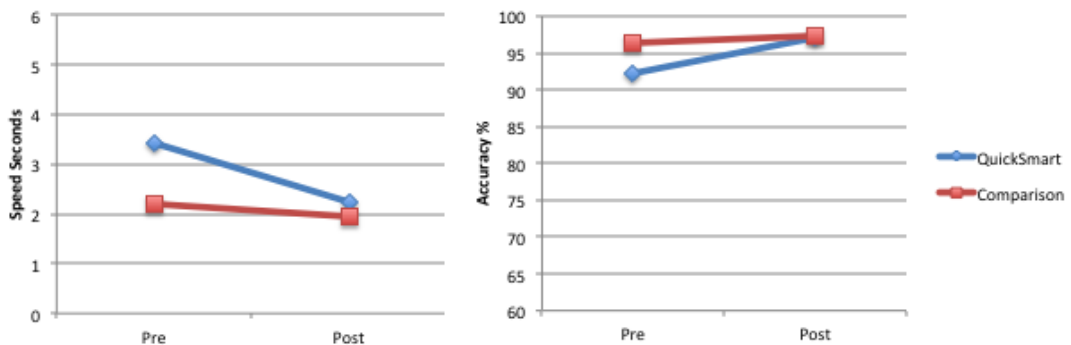
3.1.2.1 Division by Gender

The following tables show an analysis of CAAS results for each operation by gender (Tables 5, 6, 7, 8) and for Indigenous students (Table 9).

Table 5: CAAS division results – all students by gender 2009

Group	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	*p*	Effect size
Male QS (speed)	361	4.78	2.477	2.724	1.746	-2.056	<0.001*	-0.959
Male COMP (speed)	174	3.297	1.767	2.581	1.442	-0.716	<0.001*	-0.444
Female QS (speed)	328	4.946	2.487	2.712	1.91	-2.235	<0.001*	-1.008
Female COMP (speed)	168	3.717	2.224	2.729	1.489	-0.988	<0.001*	-0.522
Male QS (accuracy)	361	66.436	23.416	87.154	16.151	20.717	<0.001*	1.03
Male COMP (accuracy)	174	84.137	16.333	91.586	9.465	7.449	<0.001*	0.558
Female QS (accuracy)	328	64.567	24.6	87.777	17.207	23.21	<0.001*	1.093
Female COMP (accuracy)	168	83.945	14.928	90.455	10.666	6.51	<0.001*	0.502

The results of *QuickSmart* students show that in both speed and accuracy the females have improved slightly more than males.

3.1.2.2 Multiplication by Gender

Table 6: CAAS multiplication results – all students by gender 2009

Group	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	*p*	Effect size
Male QS (speed)	429	4.544	2.783	2.631	1.781	-1.913	<0.001*	-0.819
Male COMP (speed)	177	3.028	1.817	2.352	1.468	-0.675	<0.001*	-0.409
Female QS (speed)	386	4.549	2.686	2.585	1.682	-1.963	<0.001*	-0.876
Female COMP (speed)	174	2.712	1.39	2.285	1.118	-0.427	<0.001*	-0.339
Male QS (accuracy)	429	74.634	21.455	89.645	13.333	15.011	<0.001*	0.84
Male COMP (accuracy)	177	88.075	11.998	92.934	9.554	4.859	<0.001*	0.448
Female QS (accuracy)	386	74.819	21.032	90.445	14.235	15.626	<0.001*	0.87
Female COMP (accuracy)	174	90.412	10.143	93.144	8.263	2.732	<0.001*	0.295

The results of *QuickSmart* students show that in both speed and accuracy the females have improved slightly more than males.

3.1.2.3 Subtraction by Gender

Table 7: CAAS subtraction results – all students by gender 2009

Group	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	*p*	Effect size
Male QS (speed)	440	3.56	1.838	2.208	1.177	-1.352	<0.001*	-0.876
Male COMP (speed)	177	2.127	0.912	1.887	0.97	-0.24	<0.001*	-0.255
Female QS (speed)	401	3.795	1.885	2.339	1.209	-1.456	<0.001*	-0.92
Female COMP (speed)	174	2.328	0.856	1.969	0.724	-0.359	<0.001*	-0.453
Male QS (accuracy)	440	88.418	11.118	95.675	7.116	7.257	<0.001*	0.777
Male COMP (accuracy)	177	94.867	6.593	96.707	5.207	1.84	<0.001*	0.31
Female QS (accuracy)	401	87.386	12.319	95.953	6.806	8.567	<0.001*	0.861
Female COMP (accuracy)	174	95.783	5.245	96.776	4.394	0.993	0.033	0.205

The results of *QuickSmart* students show that in both speed and accuracy the females have improved slightly more than males.

3.1.2.4 Addition by Gender

Table 8: CAAS addition results – all students by gender 2009

Group	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	*p*	Effect size
Male QS (speed)	452	3.415	1.498	2.224	1.089	-1.19	<0.001*	-0.909
Male COMP (speed)	178	2.135	0.83	1.843	0.803	-0.292	<0.001*	-0.357
Female QS (speed)	412	3.389	1.56	2.256	0.996	-1.133	<0.001*	-0.866
Female COMP (speed)	175	2.261	0.737	2.031	0.723	-0.231	<0.001*	-0.316
Male QS (accuracy)	452	91.503	11.116	97.106	5.101	5.604	<0.001*	0.648
Male COMP (accuracy)	178	96.019	5.781	97.526	4.252	1.507	0.001	0.297
Female QS (accuracy)	412	92.811	9.426	97.198	4.934	4.387	<0.001*	0.583
Female COMP (accuracy)	175	96.726	4.485	97.163	4.661	0.438	0.382	0.096

The results of *QuickSmart* students show that in both speed and accuracy the males have improved slightly more than females.

3.1.2.5 Indigenous students

Table 9: CAAS results - Indigenous students 2009

Test	N	Pre-Mean	Pre-SD	Post-Mean	Post-SD	Gain	p	Effect size
Addition QS (speed)	102	3.767	1.764	2.453	1.117	-1.314	<0.001*	-0.89
Addition QS (acc)	102	93.227	9.277	96.055	5.619	2.827	0.003*	0.369
Sub QS (speed)	99	4.325	2.368	2.656	1.483	-1.669	<0.001*	-0.845
Sub QS (accuracy)	99	86.81	12.145	93.933	7.582	7.123	<0.001*	0.704
Mult QS (speed)	91	5.099	2.922	3.064	2.117	-2.035	<0.001*	-0.798
Mult QS (accuracy)	91	67.432	25.757	81.916	20.244	14.484	<0.001*	0.625
Division QS (speed)	63	5.449	2.917	3.472	2.794	-1.977	<0.001*	-0.692
Division QS (acc)	63	61.913	26.718	79.681	22.474	17.768	<0.001*	0.72

These results indicate that in both the pre-intervention and post-intervention the Indigenous students' mean scores were slightly lower than those of the overall *QuickSmart* group. In other words, these students had lower starting and finishing points. However, their improvement, even though slightly smaller than for the overall *QuickSmart* group, is still very strong to substantial. This is particularly so for subtraction, multiplication and division. For addition, the accuracy results exhibit the ceiling effect (the pre-intervention scores were so high that the students did not have much room for further improvement).

3.1.3 Students who were unable to complete the pre-intervention test

To complete this section on CAAS results, it is important to note that there were 437 students who the instructors confirmed were not able to complete all the CAAS pre-tests. In such cases Instructors were advised not to continue collecting data as doing so would have confronted these students dramatically with their weaknesses at the beginning of the program. A mark of the success of *QuickSmart* is that many of these students were able to complete all CAAS assessments at the end of the program. These students' results could not be included in the previous analyses and are presented in Table 10 below.

Table 10: CAAS results where no pre-test data was available - 2009

	N	Mean	Std. Deviation
Addition Speed (sec)	29	2.609	0.888
Addition Acc (%)	29	93.81	7.323
Subtraction Sp (sec)	36	2.857	1.521
Subtraction Acc (%)	36	93.628	8.364
Multiplication Sp (sec)	32	4.297	2.218
Multiplication Acc (%)	32	77.006	18.596
Division Speed (sec)	129	4.28	2.709
Division Acc (%)	129	73.778	22.447

The results in Table 10 are impressive given that these students did not have the skills or confidence to complete the CAAS pre-tests. In addition and subtraction, the average response rates were below 2.9 seconds and above 93.5% accuracy. Even though some of these students may not have progressed to multiplication and division during *QuickSmart* lessons, their results are encouraging, particularly in accuracy, with response speeds below 4.3 seconds and accuracy over 73% at post-test. It is likely that part of this improvement may be due to the fact that: (1) there has been some mutually beneficial development of the common areas of the brain that process the four operations; (2) students have increased their ability to benefit from classroom instruction; and (3) students' overall improved levels of confidence may have led to a 'have a go attitude' that was not present at the beginning of the *QuickSmart* program.

3.1.4 Conclusion on CAAS Testing

Overall, the *QuickSmart* students showed very strong growth in their understanding and use of number facts. In all four mathematical operations, they either closed the gap between them and the comparison group of average-achieving peers or narrowed this gap to a very small margin. Such growth is critical for these students as number facts are a vital skill underpinning mathematics functioning in general. This improvement provides the foundation for students to improve in other areas of mathematics that are not specifically taught in *QuickSmart*.

Some small differences between male and female students were observed. Males performed slightly better in addition speed of response and accuracy. Females performed slightly better in accuracy, and in the speed of response for all of the other operations. These differences, however, are too small to warrant further investigation.

Indigenous students had lower starting and finishing points in all operations but their overall improvement is very strong to significant.

3.2 Independent Assessments

3.2.1 Why they are used

The *QuickSmart* pre and post assessments include use of independent tests to demonstrate whether the students are able to take the basic facts and problem-solving strategies taught in *QuickSmart* and apply these to higher-level mathematical problems.

3.2.2 Results on the PATM Assessments

Table 15 reports the summary analysis of the PATM data for all students for whom paired data were available. Detailed PATM analyses for individual clusters and demographics are provided in an Appendix to this report. (Note: Students who were absent at the end of the year were not included in the analysis).

The PATM (2005) Norm Tables were used to convert raw scores from various forms of the PATM to consistent Scale scores, which were used for all subsequent calculations. Two analyses are reported in Table 15. The first analysis presents a calculation of a standard gain score and the significance of this result. The second analysis is an Effect Size calculated from the Means and Standard Deviations on PATM scores for each group to indicate the magnitude of the change in academic achievement for the *QuickSmart* and comparison students.

Table 11: PATM results - (Scale scores) 2009

Year and School number	Students with paired data	Average Gain score	Significance	Effect size
All schools – QS group	**920**	**6.006**	**<0.001***	**0.643**
All schools – Comp group	**457**	**4.947**	**<0.001***	**0.456**

The results indicate a very strong improvement for *QuickSmart* students. This improvement is greater than that of the comparison group of their average-achieving peers. The gain recorded here for the *QuickSmart* group is also well in excess of the expected yearly growth of students' scores as measured on the PATM assessment of 5 scale score points.

Table 12 reports the same information as Table 11 but shows a comparison of males and females included in the *QuickSmart* program.

Table 12: PATM results - By Gender (Scale scores) 2009

Gender	Students with paired data	Average Gain score	Significance	Effect size
Male QS Students	499	5.59	<0.001*	0.607
Male Comp Students	239	5.552	<0.001*	0.513
Female QS Students	421	6.5	<0.001*	0.686
Female Comp Students	218	4.285	<0.001*	0.394

The results indicate that the *QuickSmart* females performed slightly better than the males on the PATM test.

Table 13 reports the same information as Table 11 but does so for the scores of Indigenous students included in the *QuickSmart* program.

Table 13: PATM results - Indigenous (Scale scores) 2009

Indigenous students	Students with paired data	Average Gain score	Significance	Effect size
QS students	115	4.674	<0.001*	0.531

Once again these results show strong improvement for the Indigenous students who participated in *QuickSmart*. These students were able to report a rate of growth almost as high as the expected yearly growth of 5 scale points.

4 Conclusion to Report

The support provided by the Schools and Clusters has been critical in making more positive the hopes and aspirations of nearly 1080 students. This report has focused on the quantitative aspects of the program. In all analyses, the data report a narrowing of the achievement gap between *QuickSmart* students and their average-performing comparison group peers. Impressive Effect Sizes have been reported as well as highly significant gains on the part of individual students who, in some cases, could not complete the full suite of pre-test assessments.

Additionally, substantial qualitative data (reported in school presentations during professional workshops 2 and 3) indicate that *QuickSmart* students gained a new confidence in the area of mathematics. Many stories within the corpus of qualitative data document improvements for *QuickSmart* students not only in relation to their performance in class, but also with regard to students' attitudes to school, their attendance rates and levels of academic confidence both inside and outside the classroom.

The data collected to date from thousands of *QuickSmart* students indicate that the narrowing of the achievement gap between *QuickSmart* and comparison students results in low-achieving students proceeding with their studies more successfully by learning to 'trust their heads' in the same ways that effective learners do. Importantly, previous *QuickSmart* studies (references at http://www.une.edu.au/simerr/quicksmart/pages/qsresearchpublications.php) demonstrate that *QuickSmart* students can maintain the gains made during the program for years after they completed the program. Analyses have consistently identified impressive statistically significant end-of-program and longitudinal gains in terms of probability measures and effect sizes that mirror the qualitative improvements reported by teachers, paraprofessionals, parents and *QuickSmart* students.

If you have any questions concerning this report or *QuickSmart* please contact us at the SiMERR National Centre at UNE on (02) 67735065.

Professor John Pegg   Associate Professor Lorraine Graham

5 APPENDIX – Cluster Results

## 5.1 Standardised Test results by cluster – (Scale scores for PAT) 2009

Cluster of Schools		Pre-Intervention		Post-Intervention				
	N	Mean	SD	Mean	SD	Gain	p	Effect size
ACT – QS Group	92	41.855	8.336	45.929	8.862	4.074	<0.001*	0.474
Armidale Diocese – QS Group	12	44.025	5.939	47.792	11.814	3.767	0.112	0.403
Horsham – QS Group	140	44.812	9.421	52.49	10.552	7.678	<0.001*	0.768
Lismore Diocese – QS Group	174	41.697	8.195	50.204	9.938	8.507	<0.001*	0.934
New England Region – QS Group	9	38.622	6.57	37.933	5.536	-0.689	0.743	-0.113
North Coast Region – QS Group	93	42.51	7.481	49.683	9.325	7.173	<0.001*	0.849
Port Pirie/Adelaide Diocese – QS Group	142	43.094	6.408	49.626	8.943	6.532	<0.001*	0.84
Western Sydney – QS Group	258	36.923	7.512	40.652	8.036	3.729	<0.001*	0.479
All QS Students	**920**	**41.146**	**8.339**	**47.152**	**10.234**	**6.006**	**<0.001***	**0.643**
All Comparison students	**457**	**53.911**	**9.866**	**58.858**	**11.76**	**4.947**	**<0.001***	**0.456**

Note 1: only students who did both 'pre' and 'post' test are included in the table.

5.2 PAT results – All Students (Scale scores) 2009

Demographic		Pre-Intervention		Post-Intervention				
	N	Mean	SD	Mean	SD	Gain	*p*	Effect size
All QS Students	**920**	**41.146**	**8.339**	**47.152**	**10.234**	**6.006**	**<0.001***	**0.643**
All comparison students	**457**	**53.911**	**9.866**	**58.858**	**11.76**	**4.947**	**<0.001***	**0.456**
Indigenous QS Students	115	37.082	8.601	41.756	9.004	4.674	<0.001*	0.531
Male QS Students	499	41.507	8.313	47.097	10.038	5.59	<0.001*	0.607
Male comparison students	239	54.154	9.768	59.705	11.787	5.552	<0.001*	0.513
Female QS Students	421	40.719	8.359	47.218	10.473	6.5	<0.001*	0.686
Female comparison Students	218	53.644	9.988	57.929	11.688	4.285	<0.001*	0.394

QuickSmart Numeracy 2009 – PAT Results
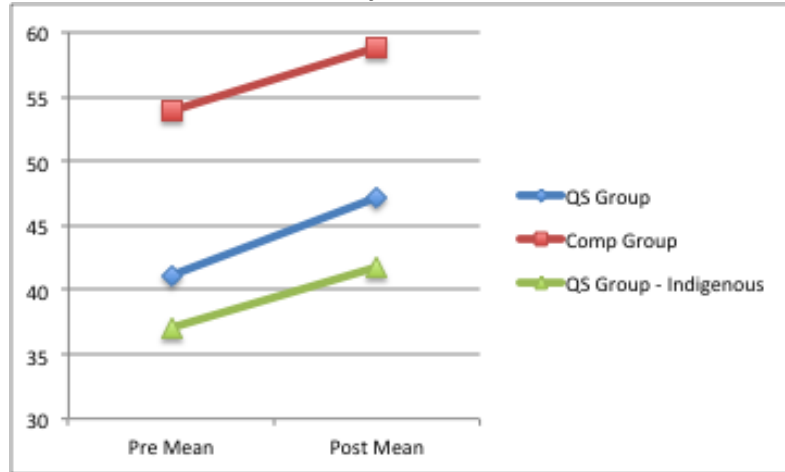
QuickSmart Numeracy 2009 – PAT Results by Gender

Note: only students who did both 'pre' and 'post' test are included in the table.