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Time limitations in NAPLAN numeracy tests

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Is the time allowed for National Assessment Program Literacy and Numeracy (NAPLAN) numeracy tests sufficient? Is there any evidence that students run out of time and, if so, what are the implications for teachers who prepare students for NAPLAN numeracy tests?

In each of the 2010 Years 7 and 9 numeracy tests students were required to complete 32 test items in 40 minutes—an average of 75 seconds per question. Norton (2009, p. 28) noted that time limitations were an issue in the 2008 Year 9 NAPLAN numeracy tests, but did not seek to examine their effect. This paper analyses the available quantitative student test response data to examine whether there is evidence of a timing issue for students.

Quantitative data

The only way to accurately determine how many students did not have enough time to complete the NAPLAN numeracy tests is to ask the students soon after completing the tests. In the absence of this information, it was necessary to make judgements based on the students' responses to test items.

The study focussed on those items where students did not record a response. There were many reasons why students might not have responded to a test item, for example, an oversight, the complexity of the item, the nature of the response required (multiple-choice or student-determined response), and the motivation of the student. To avoid capturing some of these cases, the study assumed that a student had problems with a lack of time if he/she failed to respond repeatedly to items in the last part of the test. Accordingly, "out of time" was defined to be a failure to respond to at least three of the last ten items in the test.

It is recognised that this assumption is critical to the findings of the study. As most teachers advise students to guess if they cannot respond in any other way, it is considered that the most likely reason for failing to respond to several items is lack of time. It is acknowledged that some students fail to respond to many of the items that are not multi-choice. Such students would be captured in the definition of "out of time". On the other hand, students not included were those who, aware that time was running out, rushed or guessed several responses in order to complete all items.

The study accessed data that showed students' responses to each test item in both numeracy tests. This information was made available to schools (for

their own students) in the form of a csv electronic file, but was not given to any other groups. Accordingly, this study was based on information supplied by a small number of Queensland schools who agreed to be part of the study. Of necessity, this was not a random sample. Logistic regression techniques were used to allow for the potentially biased nature of the sample, allowing the result to be extended beyond the schools in the study. A dichotomous variable "out of time" was assigned values of 1 if the condition of failing to answer three of the last ten questions was satisfied and 0 otherwise.

Year 9

The Year 9 data used in the study were available for a total of 947 students in four Queensland schools, both Government and non-Government. Of these, 70 (7.4%) ran out of time in the non-calculator test, 117 (12.4%) ran out of time in the calculator test, with 140 (14.8%) running out of time in at least one test.

Naturally, these results would be influenced inversely by the ability of the students. Given the accessibility nature of the sample, the students included in the study may not have been typical of others. To overcome the effect of any bias in the sample, the study sought to develop a logistic regression model that calculated the probability of being "out of time" for any given NAPLAN numeracy scale score[1], labelled NumScore in the analysis. The results are summarised in Table 1.

Table 1. Results of logistic regression for "out of time" data, Year 9.

	B	S.E.	Wald	df	Sig.	Exp(B)
NumScore	–0.007	0.001	29.439	1	0.000	0.993
Constant	2.438	0.760	10.296	1	0.001	11.449

By substituting the mean NAPLAN numeracy scale score for all Year 9 Queensland students into the model, the probability of a typical student running "out of time" was estimated. The analysis suggested that there was a probability of approximately 0.17 that a student with a NAPLAN numeracy scale score of 578 (the Queensland mean) would run out of time in one or both NAPLAN numeracy tests.

It was hypothesised that running out of time may also be influenced by reading ability. Accordingly, similar analysis was conducted using both the NAPLAN reading and numeracy scale scores as independent variables in the logistic regression model. However, the reading scale score did not prove to be significant.

Year 7

The study also had access to similar data for Year 7 students in two schools. Unfortunately, the regression analysis of the Year 7 results similar to that undertaken for the Year 9 results yielded unreliable outcomes. However, one of the schools, with 209 students in Year 7, had a mean NAPLAN numeracy scale score of 545, the same as the Queensland mean. In this school, 22% of students ran out of time. Naturally, caution must be exercised in relying on the results of a single school, albeit with a large Year 7 enrolment.

1 Details of the meaning of scale scores can be found at the MySchool website (Australian Curriculum Assessment and Reporting Authority, 2010b).

Discussion

Practicality requires that tests are of a finite duration and there will always be some students who do not complete the tests in the available time. Whilst it becomes a matter for judgement as to whether a given non-completion rate is unacceptable, it is suggested, that a figure of up to 17%, as suggested by this study, is too high. The content of the 2010 NAPLAN numeracy tests was based on the *Statement of Learning for Mathematics* (Curriculum Corporation, 2006). There is no requirement in this statement that students should work under time pressure. It is submitted, therefore, that it is unreasonable to impose this condition on one out of every six students in NAPLAN numeracy tests. In these circumstances, a non-completion rate of less than 10% might be acceptable.

Selected NAPLAN Questions

It not possible in an article of this length to analyse every question in the NAPLAN numeracy tests in detail. However, one example may serve to illustrate the nature of the problem.

Question 9 in the 2010 Year 7 calculator test (Australian Curriculum Assessment and Reporting Authority, 2010a) provided students with a two-dimensional table showing the number of people attending sport training on each weekday of a four week period. Students were asked to find which day of the week had the greatest total attendance. The options offered to students were Monday, Tuesday, Wednesday and Thursday.

The author observed 10 Year 7 students of varying abilities complete this question. Nine of the students chose to add all four rows using their calculator, and then select the largest value. Only one student attempted to use estimation to find the answer (adopting an incorrect method). One other student recognised that the total for Thursday had to be less than the total for at least one of other days, but chose to add the row anyway. When another student was asked why he did not use estimation, he said, "I like to be certain."

Questions that test simple concepts should be quick for students to answer so that they can accumulate the additional time needed for more complex questions. As a result of the time-consuming method used by nine of the students, this relatively straightforward question took them significantly more than the average of seventy five seconds available for each question. Whilst 74% of all students in Australia answered this question successfully, it must be asked whether the amount of time taken to respond to this question affected their success in later questions.

If the purpose of the question was to test the ability of students to identify the need for, and use, appropriate estimation techniques, then the question failed to elicit the desired response in any of the 10 students observed. There are two possible reasons for the fact that nine of the 10 students did not attempt to use estimation techniques. Firstly, Year 7 students may not have thought to look for alternative approaches to a question in order to select the most time-efficient method. Secondly, estimation may not have been seen as a legitimate technique in a test where the availability of calculators implied that accuracy was important.

Questions like this one, that many students would attempt to answer by testing all four of the available options, typically take longer than questions where students can calculate the answer directly. Table 2 lists similar questions in the 2010 tests.

Test writers should consider whether the same concepts could have been assessed in less time-consuming ways.

Table 2. Possible time-consuming questions in the 2010 NAPLAN numeracy tests.

Test	Question	Details
7 non-calc	25	Testing different arrangements of 4 digits in a 3 digit by 1 digit product to give a specified result
7 calc	14	Testing which of four divisors (43, 45, 47, 49) of 4465 gives a whole number quotient
	25	Matching four pairs of results in a table to four different linear equations
9 non-calc	5	Testing 4 sets of 3 numbers to satisfy an inequality with 3 independent variables
	21	Examining four different algebraic expressions to determine which results in the largest value when a specified variable is less than one
9 calc	17	Finding the shortest path in a network of 6 possible paths
	18	Same as question 25 in the Year 7 calculator test

Implications for teachers

The main purpose of this article is to alert teachers to the possibility that lack of time may be a concern for students in NAPLAN numeracy tests. Given the limitations of the data available to this study, teachers should question their own students and examine the NAPLAN numeracy results to determine if time limitations cause problems for them. Class groups of students could be questioned about the adequacy of the time available after practice tests (a show of hands would be sufficient)[2]. Data files showing the results from past NAPLAN numeracy tests and the responses of students to NAPLAN practice tests could be examined for evidence of students running out of time. Whilst most schools would not have the resources to undertake logistic regression, they should be able to make judgements that take into account the abilities of their own students.

There are several strategies that teachers could use to assist students to work more quickly.

- Improving mental arithmetic skills. A calculator is a time consuming alternative to mental computations. Norton (2009, p. 27), analysing the 2008 Year 9 NAPLAN calculator allowed test, found that the use of a calculator would have been of significant assistance for only two of the questions, assuming that students possessed "reasonable computation ability".
- When teaching problem solving, teachers should encourage students to consider whether there is more than one method of responding to a question. Estimation should be presented as a legitimate strategy when eliminating multiple choice options or in other situations when accuracy is not critical. It can be rehearsed regularly in the context of problem solving as a method of verifying solutions. Marking schemes for school assessment should accept estimation where appropriate.
- When preparing students for NAPLAN numeracy tests, teachers must encourage students to take account of the amount of time available to them. Where possible, students should recognise that several strategies could be used to solve a particular problem and identify those that are the most time-efficient. The aim is to encourage students to consider more than one strategy for answering a NAPLAN numeracy test question and in order to select the most rapid method. For Year 7 students in particular this may require considerable practice.

2 One of the schools involved in this study undertook this 'show of hands' analysis immediately after the 2011 NAPLAN numeracy tests and found that 30.5% of 204 Year 9 students and 15.2% of 158 Year 7 students indicated that they needed more time in at least one of the 2011 numeracy tests.

Implications for NAPLAN test developers

The adequacy, or otherwise, of the time available to students in NAPLAN numeracy has important implications for the validity of NAPLAN numeracy data. It would be of relevance to all teachers of numeracy to know what the Australian Curriculum Assessment and Reporting Authority (ACARA) considers an acceptable level of non-completion of the tests, and this information should be made available to teachers.

The unavailability of detailed NAPLAN data to anyone other than the school concerned makes it impossible for anyone outside the relevant government agencies to rigorously analyse of the effect of time limitations on students attempting NAPLAN numeracy tests. Accordingly, it is recommended that ACARA undertake a quantitative study, using the results of all students or of a randomly selected sample of students, to determine how time limitations in the various NAPLAN numeracy tests affect students' ability to show what they can do. As the entire community has a legitimate interest in this information, the results of the research should be published on the ACARA website. If the research indicates that students do not have sufficient time to show what they know and can do in NAPLAN numeracy tests, ACARA must take account of these findings when developing future NAPLAN numeracy tests.

Whilst this article has focussed on the NAPLAN numeracy tests, there would be value in conducting a similar analysis of NAPLAN testing in the other domains.

Conclusion

There are indications that some students may not have had sufficient time to show what they could do in the 2010 Year 7 and 9 NAPLAN numeracy tests. Despite limitations of the lack of data available to this study, there is enough evidence to alert all schools that lack of time in Year 7 and 9 NAPLAN numeracy tests could be a concern for some students. Schools should investigate whether this applies to their own students. If time limitations have an adverse impact on significant numbers of students, then this has important implications for teachers preparing students for NAPLAN tests and for the developers of the tests.

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