**Purposes of assessment**

The purposes of assessment are to:

- promote, assist and improve student learning
- inform programs of teaching and learning
- provide information for those people — students, parents, teachers — who need to know about the progress and achievements of individual students to help them achieve to the best of their abilities
- provide information for the issuing of certificates of achievement
- provide information to those people who need to know how well groups of students are achieving (school authorities, the State Minister for Education and Training and the Arts, the Federal Minister for Education).

It is common practice to label assessment as being formative, diagnostic or summative, according to the major purpose of the assessment.

The major purpose of formative assessment is to help students attain higher levels of performance. The major purpose of diagnostic assessment is to determine the nature of students' learning, and then provide the appropriate feedback or intervention. The major purpose of summative assessment is to indicate the achievement status or standards achieved by students at a particular point in their schooling. It is geared towards reporting and certification.

**Syllabus requirements**

Teachers should ensure that assessment instruments are consistent with the requirements, techniques and conditions of the Mathematics C syllabus and the implementation year 2009.

**Assessment instruments**

High-quality assessment instruments:

- have construct validity (the instruments actually assess what they were designed to assess)
- have face validity (they appear to assess what you believe they are intended to assess)
- give students clear and definite instructions
- are written in language suited to the reading capabilities of the students for whom the instruments are intended
- are clearly presented through appropriate choice of layout, cues, visual design, format and choice of words
- are used under clear, definite and specified conditions that are appropriate for all the students whose achievements are being assessed
- have clear criteria for making judgments about achievements (these criteria are shared with students before they are assessed)
- are used under conditions that allow optimal participation for all
- are inclusive of students’ diverse backgrounds
- allow students to demonstrate the breadth and depth of their achievements
- only involve the reproduction of gender, socioeconomic, ethnic or other cultural factors if careful consideration has determined that such reproduction is necessary.

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2 Assessment instruments are the actual tools used by schools and the QSA to gather information about student achievement, for example, recorded observation of a game of volleyball, write-up of a field trip to the local water catchment and storage area, a test of number facts, the Senior External Examination in Chinese, the 2006 QCS Test, the 2008 Year 4 English comparable assessment task.
Mathematics C (2008)

Sample assessment instrument and student response

Extended modelling and problem solving

Compiled by the Queensland Studies Authority
June 2010

About this assessment instrument

The purpose of this document is to inform assessment practices of teachers in schools. For this reason, the assessment instrument is not presented in a way that would allow its immediate application in a school context. In particular, the assessment technique is presented in isolation from other information relevant to the implementation of the assessment. For further information about those aspects of the assessment not explained in this document, please refer to the assessment section of the syllabus.

This sample provides opportunities for students to demonstrate:

- recall, access, selection and application of mathematical definitions, rules and procedures
- selection and use of mathematical technology
- application of problem-solving strategies and procedures to identify problems to be solved and interpret, clarify and analyse problems
- representation of situations by using data to synthesise mathematical models and generate data from mathematical models
- modification of mathematical models as appropriate
- interpretation and use of appropriate mathematical terminology, symbols and conventions
- analysis of information displayed in a variety of representations (such as written, symbolic, pictorial and graphical) and translation of information from one representation to another
- development and use of coherent, concise and logical sequences within a response expressed in everyday language, mathematical language or a combination of both, as required, to justify conclusions, solutions or propositions
- justification of the reasonableness of results obtained through technology or other means using everyday language, mathematical language or a combination of both.

This sample assessment instrument is intended to be a guide to help teachers plan and develop assessment instruments for individual school settings.
Assessment instrument

Your textbook outlines some examples of how matrices may be used to model real-life scenarios in order to make some informed predictions of future possibilities in those scenarios. Namely, your text investigates the use of Markov chains, Leslie matrices and Dominance matrices, in this regard.

In this extended modelling and problem solving task, you will:

1. Use your textbook or other resources to research one matrix method from Markov chains, Leslie matrices or Dominance matrices
2. Provide a general outline of the processes involved in your chosen matrix method
3. Decide on a real-life scenario that can be modelled using your chosen matrix method, providing concise reasons for your choice
4. Collect historical, real-life data from a reliable source that can be used in your chosen matrix method, providing appropriate referencing of your source
5. Use this actual data to define and refine a matrix model for your chosen scenario
6. Use your matrix model to make a “prediction”, which must be validated by using additional historical data (which, again, must be referenced appropriately)
7. Comment on the validity of your matrix model for your chosen scenario
8. Present all your work for this assignment in a suitable form, including appropriate referencing of resources used (including your textbook)

This task list must be read in conjunction with the task-specific criteria sheet, and completed by negotiation with your teacher.

You are encouraged to work with others in the completion of this assignment, but your data and final submission should be independent of others’ work.
Instrument-specific criteria and standards

Schools draw instrument-specific criteria and standards from the syllabus dimensions and exit standards. Schools will make judgments about the match of qualities of student responses with the standards descriptors that are specific to the particular assessment instrument. While all syllabus exit descriptors might not be assessed in a single assessment instrument, across the course of study, opportunities to demonstrate all the syllabus dimensions and standards descriptors must be provided.

The assessment instrument presented in this document provides opportunities for the demonstration of the following criteria:

- knowledge and procedures
- modelling and problem solving
- communication and justification.

This document provides information about how the qualities of student work match the relevant instrument-specific criteria and standards at standard A. The standard A descriptors are presented below. The complete set of instrument-specific criteria and standards is in the appendix.

<table>
<thead>
<tr>
<th>Standard A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge and procedures</td>
</tr>
<tr>
<td>The student’s work has the following characteristics:</td>
</tr>
<tr>
<td>• recall, access, selection of mathematical definitions, rules and procedures in routine and non-routine simple tasks through to routine complex tasks, in life-related situations</td>
</tr>
<tr>
<td>• application of mathematical definitions, rules and procedures in routine and non-routine simple tasks through to routine complex tasks, in life-related situations</td>
</tr>
<tr>
<td>• appropriate selection and accurate use of technology.</td>
</tr>
</tbody>
</table>

| Modelling and problem solving |
| The student’s work has the following characteristics: |
| • use of problem-solving strategies to interpret, clarify and analyse problems to develop responses from routine simple tasks through to non-routine complex tasks in life-related situations |
| • use of data to synthesise mathematical models and generation of data from mathematical models in simple through to complex situations |
| • refinement of mathematical models. |

| Communication and justification |
| The student’s work has the following characteristics: |
| • appropriate interpretation and use of mathematical terminology, symbols and conventions from simple through to complex and from routine through to non-routine, and in life-related situations |
| • analysis and translation of information from one representation to another in life-related situations from simple through to complex and from routine through to non-routine |
| • use of mathematical reasoning to develop coherent, concise and logical sequences within a response from simple through to complex and in life-related situations using everyday and mathematical language |
| • coherent, concise and logical justification of procedures, decisions and results |
| • justification of the reasonableness of results. |
Sample student responses: Standard A

<table>
<thead>
<tr>
<th>Standard descriptors</th>
<th>Student response A</th>
</tr>
</thead>
</table>

**Dominance Matrices**

Dominance Matrices are a special type of matrix that can help mathematically rank sporting teams/players. In accurately tabulating sporting results into a dominance matrix, one can apply a series of mathematical calculations to ultimately produce a column matrix, which clearly defines the rank of each competitor.

Matrices of this type have a fixed configuration. In the Dominance Matrix, 1 is assigned for a win, 0 for a loss or non-confrontation, and a ½ for a draw. Of course, no team/player ever competes against themselves, so the terms on the leading diagonal are 0.

\[
\begin{bmatrix}
A & B & C & D \\
0 & 0 & 1 & 0 \\
1 & 0 & 0 & 1 \\
0 & 1 & 0 & 0 \\
1 & 0 & 1 & 0
\end{bmatrix}
\]

For example, Matrix M represents the confrontation of 4 teams in a competition — Team A, Team B, Team C and Team D. This competition is in a round-robin format, that is, every team plays every other team once. Going by the conventions of Dominance Matrices, it can be stated that:

- Team A defeated team C
- Team B defeated team A and team D
- Team C defeated team B
- Team D defeated team A and team C

Teams B and D gained victory twice, whilst teams A and C gained victory once, resulting in what could be termed a draw for both 1st and 4th positions. Hence, it is hard to discern the most successful team as their totals are not all different, in the same way that it is to identify the bottom-most team.

In order for an initial rank order to be determined, the total number of wins – total number of losses must be calculated. This operation can be performed using \( M_1 \cdot M^\top_1 \) (where one is a column matrix of 1s) which ensures that the players are ranked according to how many victories they have secured. This is also referred to as the first-order ranking, or r.
Appropriate interpretation and use of mathematical terminology, symbols and conventions in a complex, non-routine life-related situation.

The resultant column matrix, or the first order rank vector, provides the total number of wins – total number of losses made by each team. From the matrix, it is evident that both Player B and D have won 1 more game than they have lost, and both Player A and C have lost one more game than they have won.

This calculation however, does not bear into play the fact that if Team X, for example, defeats Team Y, then theoretically Team X should also be able to beat any Team that is has been defeated by Team Y, which is clearly demonstrated through there still being no distinction between the teams. In reality, the "Team X and Team Y" scenario will not always be true, but it allows for the available information to be extrapolated, thus enabling a group of players to be ranked more accurately.

In saying this, the second-order rank vector (attained from applying the second order ranking method), or \( r_2 \), is needed to be established. This method works on the basis of the sum of the opponent's points, and can be determined by calculating \( M^1 \cdot (M^1)^{-1} \).

\[
M^1 = \begin{bmatrix}
A & B & C & D \\
A & 0 & 1 & 0 & 1 \\
B & 0 & 0 & 1 & 0 \\
C & 1 & 0 & 0 & 1 \\
D & 0 & 1 & 0 & 0
\end{bmatrix}
\]

\[
M^1 - M^1 \cdot r_2 
\]

\[
\cdot \begin{bmatrix}
1 \\
-1 \\
1 \\
1
\end{bmatrix}
\]

\[
r_2 = \begin{bmatrix}
2 \\
2 \\
2
\end{bmatrix}
\]
Coherent, concise, and logical justification of procedures

\[
M^2 = \begin{bmatrix}
0 & 0 & 1 & 0 \\
1 & 0 & 0 & 1 \\
0 & 1 & 0 & 0 \\
1 & 0 & 1 & 0 \\
\end{bmatrix}
\begin{bmatrix}
0 & 0 & 1 & 0 \\
1 & 0 & 0 & 1 \\
0 & 1 & 0 & 0 \\
1 & 0 & 1 & 0 \\
\end{bmatrix}
\]

\[
(M^2)^T = \begin{bmatrix}
0 & 1 & 1 & 0 \\
1 & 0 & 0 & 1 \\
1 & 2 & 0 & 1 \\
0 & 0 & 1 & 0 \\
\end{bmatrix}
\]

\[
M^1 \cdot (M^2)^T = \begin{bmatrix}
0 & 1 & 0 & 0 \\
1 & 0 & 2 & 0 \\
1 & 0 & 0 & 1 \\
0 & 1 & 1 & 0 \\
\end{bmatrix}
\begin{bmatrix}1 \\
1 \\
1 \\
1 \\
\end{bmatrix}
\]

\[
= \begin{bmatrix}1 \\
3 \\
2 \\
2 \\
\end{bmatrix}
- \begin{bmatrix}2 \\
2 \\
3 \\
1 \\
\end{bmatrix}
\]

\[
r_2 = \begin{bmatrix} -1 \\
1 \\
1 \\
1 \\
\end{bmatrix}
\]

To attain an overall, resolved ranking of all teams, both \(r_1\) and \(r_2\) are simply added.

\[
r_1 + r_2 = \begin{bmatrix} -1 \\
1 \\
-1 \\
1 \\
\end{bmatrix}
+ \begin{bmatrix} -1 \\
1 \\
-1 \\
1 \\
\end{bmatrix}
\]

\[
= \begin{bmatrix} -2 \\
2 \\
-2 \\
2 \\
\end{bmatrix}
\]
Use of problem-solving strategies to interpret, clarify and analyse problems to develop responses in a non-routine complex life-related situation.
Standard A

Appropriate selection and accurate use of technology

Application of mathematical definitions, rules and procedures in a non-routine, complex life-related situation

\[
M^1 \cdot (M^2)^1 = \begin{bmatrix}
1 & 0 & 0 & 1 \\
0 & 2 & 1 & 0 \\
1 & 0 & 2 & 0 \\
1 & 1 & 0 & 1
\end{bmatrix} \begin{bmatrix}
1 \\
1 \\
1 \\
1
\end{bmatrix} = \begin{bmatrix}
1 & 0 & 1 & 1 \\
0 & 2 & 0 & 1 \\
0 & 1 & 2 & 0 \\
1 & 0 & 0 & 1
\end{bmatrix} \begin{bmatrix}
1 \\
1 \\
1 \\
1
\end{bmatrix}
\]

\[
= \begin{bmatrix}
2 \\
3 \\
3 \\
3
\end{bmatrix} \cdot \begin{bmatrix}
3 \\
3 \\
2 \\
2
\end{bmatrix} = \begin{bmatrix}
-1 \\
0 \\
0 \\
1
\end{bmatrix}
\]

To resolve the rankings, the three vectors must be added together

\[
r_1 + r_2 + r_3 = \begin{bmatrix}
-1 \\
1 \\
-1 \\
1
\end{bmatrix} + \begin{bmatrix}
-1 \\
1 \\
-1 \\
1
\end{bmatrix} + \begin{bmatrix}
-1 \\
0 \\
0 \\
1
\end{bmatrix}
\]

A  =  \begin{bmatrix}
-3 \\
2 \\
-2 \\
3
\end{bmatrix}

B  =  \begin{bmatrix}
-3 \\
2 \\
-2 \\
3
\end{bmatrix}

C  =  \begin{bmatrix}
-3 \\
2 \\
-2 \\
3
\end{bmatrix}

D  =  \begin{bmatrix}
-3 \\
2 \\
-2 \\
3
\end{bmatrix}

From the resultant vector matrix, it can be clearly deciphered that the rankings are (from first to fourth): Team D, Team B, Team C and Team A.

In any rare instance, if calculating the third-rank order rank vector still doesn't resolve the rankings, the second- and third-order rankings weighted by a factor method can be applied. In multiplying the second and third rank order rank vectors by any number less than 1 (e.g. 0.5, 0.25), the importance of \( r_2 \) and \( r_3 \) can be diminished compared with \( r_1 \), thus revealing the 'true leader.'
It is to be noted, however, that by the third-order ranking method stage, it is probable that
the competitors are of almost the same skill-level anyway, and thus deserve to hold a tie for
their respective positions.

Application of Dominance Matrices surprised

Matrices such as this one are most commonly applicable in sporting situations, where match
scores and overall point tables can be used to determine the team rankings. For this task I
have chosen to model statistics from Netball Australia (Netball Australia, 2009), pertaining to
the 2008 Australian Netball Championships.

ROUND RESULTS

**Round Name: Round 1 Starting Date: 01/04/2008**

<table>
<thead>
<tr>
<th>Home Team</th>
<th>Away Team</th>
<th>Score</th>
<th>Result</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIC</td>
<td>QLD</td>
<td>42</td>
<td>V</td>
<td>01/04/2008 3:00PM</td>
</tr>
<tr>
<td>NT</td>
<td>QLD</td>
<td>19</td>
<td>V</td>
<td>01/04/2008 9:30AM</td>
</tr>
<tr>
<td>WA</td>
<td>ACT</td>
<td>19</td>
<td>V</td>
<td>01/04/2008 10:30AM</td>
</tr>
<tr>
<td>SA</td>
<td>ACT</td>
<td>27</td>
<td>V</td>
<td>01/04/2008 11:00AM</td>
</tr>
</tbody>
</table>

**Round Name: Round 2 Starting Date: 01/04/2008**

<table>
<thead>
<tr>
<th>Home Team</th>
<th>Away Team</th>
<th>Score</th>
<th>Result</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIC</td>
<td>QLD</td>
<td>33</td>
<td>V</td>
<td>01/04/2008</td>
</tr>
<tr>
<td>NT</td>
<td>QLD</td>
<td>9</td>
<td>V</td>
<td>01/04/2008</td>
</tr>
<tr>
<td>SA</td>
<td>QLD</td>
<td>25</td>
<td>V</td>
<td>01/04/2008</td>
</tr>
<tr>
<td>WA</td>
<td>QLD</td>
<td>20</td>
<td>V</td>
<td>01/04/2008</td>
</tr>
</tbody>
</table>

**Round Name: Round 3 Starting Date: 02/04/2008**

<table>
<thead>
<tr>
<th>Home Team</th>
<th>Away Team</th>
<th>Score</th>
<th>Result</th>
<th>Date/Time</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW</td>
<td>ACT</td>
<td>33</td>
<td>V</td>
<td>02/04/2008</td>
</tr>
<tr>
<td>ACT</td>
<td>QLD</td>
<td>10</td>
<td>V</td>
<td>02/04/2008</td>
</tr>
<tr>
<td>QLD</td>
<td>TAS</td>
<td>38</td>
<td>V</td>
<td>02/04/2008</td>
</tr>
<tr>
<td>TAS</td>
<td>QLD</td>
<td>19</td>
<td>V</td>
<td>02/04/2008</td>
</tr>
</tbody>
</table>
### Extended modelling and problem solving

#### Sample assessment instrument and student responses

<table>
<thead>
<tr>
<th>Round Name: Round 4</th>
<th>Starting Date: 02/04/2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIC</td>
<td>(22)</td>
</tr>
<tr>
<td>ACT</td>
<td>(27)</td>
</tr>
<tr>
<td>QLD</td>
<td>(19)</td>
</tr>
<tr>
<td>TAS</td>
<td>(24)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round Name: Round 5</th>
<th>Starting Date: 03/04/2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>NSW</td>
<td>(39)</td>
</tr>
<tr>
<td>TAS</td>
<td>(18)</td>
</tr>
<tr>
<td>WA</td>
<td>(15)</td>
</tr>
<tr>
<td>NT</td>
<td>(12)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round Name: Round 6</th>
<th>Starting Date: 03/04/2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>QLD</td>
<td>(44)</td>
</tr>
<tr>
<td>NSW</td>
<td>(38)</td>
</tr>
<tr>
<td>SA</td>
<td>(44)</td>
</tr>
<tr>
<td>VIC</td>
<td>(41)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Round Name: Round 7</th>
<th>Starting Date: 04/04/2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACT</td>
<td>(19)</td>
</tr>
<tr>
<td>WA</td>
<td>(19)</td>
</tr>
<tr>
<td>SA</td>
<td>(22)</td>
</tr>
<tr>
<td>QLD</td>
<td>(36)</td>
</tr>
</tbody>
</table>
Use of mathematical reasoning to develop coherent, concise and logical sequences within a complex life-related response using everyday language.

Scenario

At the conclusion of the initial rounds of the competition, it was noted that Victoria and New South Wales were tying for 1st position, whilst the Tasmanian and Australian Capital Territory teams were tying for 6th position, as were the Western Australian and Northern Territory teams for 8th position. For a competition of this level, intensity and entertainment value, having a distinct winner is of vital importance, not only for the teams/competition’s sake, but also for sponsorship and betting purposes. This is the reason for elimination rounds, where the outcomes of the games played determine the final winners of the competition. Hence I have chosen to tabulate the competition results up to and including round 7, in order to make a well-grounded prediction on the outcome of the subsequent elimination and semi-final rounds of the competition, and most importantly, predict the team to win. At this point in the competition it is unclear who may win, as it is what the clear rank order may be. In calculating, through matrix modeling, what the rank order of the teams are, one can gain a fair idea of the likelihood of one team to win over another, and thus place a rough estimate on the outcome of the competition.

Matrix Model

The following table shows a summary of the confrontation results of each team, with 1 signifying a win, 0 a loss, and $\frac{1}{2}$ a tie. The information was attained from the ROUND RESULTS.

<table>
<thead>
<tr>
<th>Team</th>
<th>VIC</th>
<th>NSW</th>
<th>QLD</th>
<th>SA</th>
<th>WA</th>
<th>TAS</th>
<th>ACT</th>
<th>NT</th>
</tr>
</thead>
<tbody>
<tr>
<td>VIC</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>NSW</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>QLD</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>$\frac{1}{2}$</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>SA</td>
<td>0</td>
<td>0</td>
<td>$\frac{1}{2}$</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>WA</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>TAS</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ACT</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>NT</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
### Use of data to synthesise mathematical models in complex situations

Let the matrix formed from this information be $D$:

$$
D = \begin{bmatrix}
0 & 0 & 1 & 1 & 1 & 1 & 1 & 1 \\
1 & 0 & 0 & 1 & 1 & 1 & 1 & 1 \\
0 & 1 & 0 & 1/2 & 1 & 1 & 1 & 1 \\
0 & 0 & 1/2 & 0 & 1 & 1 & 1 & 1 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 1 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
\end{bmatrix}
$$

### Translation of information from one representation to another in a complex, life-related non-routine situation

#### In the subsequent games – prediction

In order for any predictions on subsequent rounds to be made, initially, the first-order rank vector must be calculated. The following calculations were done using the CASIO GRAPHICS CALCULATOR. Note: For all the calculations $1$s is a column matrix of $1$s.

$$D1 - D^T1 =$$

$$r_1 = \begin{bmatrix}
5 \\
5 \\
4 \\
2 \\
-5 \\
-3 \\
-3 \\
-5 \\
\end{bmatrix}$$

It is still unclear, even after calculating the first-order rank vector, what the distinct rank order is, and which team is more likely to win the competition. Therefore, the second-order rank vector is calculated.
Use of problem-solving strategies to interpret, clarify and analyse problems to develop responses in non-routine complex life-related situations

\[ (D \cdot r)_1 - (D \cdot r)_1 = r_2 = \]

\[ r_1 + r_2 = \]

\[ = \]

The rankings, however, were still the same, with an order of Victoria and NSW tying for 1st position, Queensland at 3rd position, South Australia at 4th, and both Tasmania and the Australian Capital Territory and Western Australia and the Northern Territory tying for 5th and 8th positions, respectively. For this reason, it was decided that both the second-order ranking weighted by a factor method, and if not resolved by this, the third order rank vector method must be applied.
Recall, access, selection of mathematical definitions, rules and procedures in a non-routine complex life-related situation.

\[ r_1 + 0.5r_2 = \begin{bmatrix} 5 \\ 5 \\ 4 \\ 2 \\ -5 \\ -3 \\ -3 \\ -5 \end{bmatrix} + 0.5 \begin{bmatrix} 15 \\ 15 \\ 12 \\ 6 \\ -15 \\ -9 \\ -9 \\ -15 \end{bmatrix} \]

As shown above, the second-order ranking weighted by a factor method, using a factor of 0.5 was insufficient in differentiating between certain teams. Hence, the third-order rank vector was calculated.

\[ D^3 - (D^3)^T = \begin{bmatrix} 29.5 \\ 33.5 \\ 26.5 \\ 11.5 \\ -31.5 \\ -21.5 \\ -16.5 \\ -28.5 \end{bmatrix} \]
Standard A

\[
\begin{align*}
\text{\( r_1 + r_2 + r_3 = \)} & \text{ 49.5  VIC} \\
\text{ 50.5  NSW} & \\
\text{ 42.5  QLD} & \\
\text{ 19.5  SA} & \\
\text{ 51.5  WA} & \\
\text{ 33.5  TAS} & \\
\text{ 26.5  ACT} & \\
\text{ 48.5  NT} &
\end{align*}
\]

It can be predicted with some confidence that the rank orders would (roughly) be as follows:

- NSW
- VIC
- QLD
- SA
- ACT
- TAS
- NT
- WA

This is assuming, however, that the players are playing under similar conditions e.g. length of match, court surface, indoors (thus weather conditions have no impact). The numbers in the resultant vector, however, are very similar and close, making for the ease in predicting that the competition will be very close. This is also determined by the fact that up to the blind-order ranking had to be calculated in order for distinct rankings to be attained. So, in saying that this is the predicted rankings for the ultimate result, it is also maintained that the results will be very close, and even the unexpected is to be expected.

With regard to the winning team, it can be predicted that since New South Wales have dominated the competition thus far, they are most likely to play triumphantly in the upcoming rounds. However, Victoria is only 1 rank point under New South Wales, making for an extremely intense next few rounds. As the Queensland team, however, is a whole 7 rank points behind Victoria, it can be concluded that it will be more likely to maintain 3rd position and may not be too serious a competition for the top 2 teams.

Validity of Matrix Model

The following tables show the results of the semi-final and elimination rounds and the final team placings at the conclusion of the competition.
Standard A

The ultimate results of the competition were fairly similar to those predicted, including various exact placements. They were, however, some startling results.

From the predicted rankings, it was certain that New South Wales would win the competition, particularly based on their dominating status in the preliminary rounds. This, however, was proven wrong, with Victoria shining through in the final few rounds and securing their position as the winners of the competition. Despite this, New South Wales was the defending champion and provided a tough competition to all other teams. The victory of Victoria winning, despite the prediction that New South Wales would dominate, is largely supported by the fact the estimated rankings for New South Wales and Victoria were very close, with 50.5 and 49.5 respectively. With a difference of only 1, a close competition...
such as this was expected. Queensland and South Australia were predicted to place 3rd and 4th respectively, which was exactly the outcome of the competition.

The outcome of the fight for the next four placements was, in some respects, the slightest of what was expected. The Australian Capital Territory team, based on the -28.5 ranking attained from the first 7 rounds, was expected to maintain 5th position. However, the end of the competition saw them make their way to the 2nd-lowest position of the ladder. Tasmania, as calculated, finished on 8th position. This was somewhat to be expected as there was only a 5 point difference between the two teams (ACT on -28.5 and TAS on -33.5), indicating a fairly tight competition between the two in the elimination rounds (that is, on the basis of them playing with a similar success rate, game-style and technique as in previous rounds).

From the resultant 'prediction' matrix, it was noted that with Northern Territory on -48.5 and Western Australia on -51.5, they would be left to a grueling and intense fight for what would possibly be 7th position — a fight that would however be less impactful on the positions of the others two 'bottom-four' teams (substantiated by the 13 point difference between Northern Territory and the next best team, Tasmania). This was, however, where the earlier prediction was most severely negated. Western Australia, the team who was predicted to come 8th and thus pose no threat to at least Australian Capital Territory and Tasmania, defeated all the other 'bottom-four' teams to secure its position as the 5th most successful team in the competition. This shows that as much as an accurate prediction can be made, the game of netball is terribly unpredictable and can see the tables turn for a variety of reasons. The Northern Territory team, who were initially predicted to come 7th, landed the last position of the competition. Considering as they were anyway ranked as the weakest out of the 5th, 6th and 7th best teams on the prediction table (with a 13 point difference from Tasmania). It is justified that with Western Australia's sudden chain of victories, they were to place last.

During a game of such intensity, there are various 'ungovernable' factors that may have an impact on any one team's performance. The first, and most palpable reason for a team's poor performance would be if they were playing in front of an away crowd. It is a known fact in the sporting industry that playing in the presence of your home crowd can mean a tremendous boost in confidence, and for the opposing team, the exact opposite effect: that of unease and anxiety. Another key factor may include the unforeseen injury of a vital player, resulting in a general loss of confidence on a team's behalf and the last-minute urgency to play a tougher, more assertive game. Teams may also find that although they may be in the favour of winning, they may just be having a 'bad' day and sensing an under-performance. Other factors include each individual's own emotional state during the time of the match and thus the overall ability of the team to perform under the pressure situation.

Any one or more of these reasons could have been the determining factor(s) of Western Australia's sudden ascent of the ladder, or more rightly, its opponents' descent of the same. Another more 'technical' reason could be that after the 7 initial rounds of the competition, the Western Australian team would have noticed some trends in the game tactics of the three other teams and would have come up with a more strategised and team-specific game
plan, resulting in a general improvement in their performance as a team. In any case, the
fact that the third ranking vector needed to be calculated to get a deciphering factor
between the teams’ rankings clearly demonstrates the tightness of the competition.

Overall, the method of the Dominance Matrix was fairly successful in determining the final
positioning of the teams on the competition ladder, as it was in reflecting how tense the
competition really was. It made for an ease in calculating and knowing the accurate ranking
of each team, as well as predicting the team to win, yielding the capacity of making
informed predictions about the outcomes of such competitions.

thorough analysis
and complete knowledge of
dominance their shown.

References / Resources

References:

1. Netball Australia, 2009, viewed 20th April 2009,

Resources:

1. New Maths 11C, Ross Brodie and Stephen Swift, Pages 186 – 194 Inclusive
3. CASIO Graphics Calculator
## Instrument-specific criteria and standards

<table>
<thead>
<tr>
<th>Knowledge and procedures</th>
<th>Standard A</th>
<th>Standard B</th>
<th>Standard C</th>
<th>Standard D</th>
<th>Standard E</th>
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<td>use of problem-solving strategies to interpret, clarify and analyse problems to develop responses from routine simple tasks through to non-routine complex tasks in life-related situations</td>
<td>use of problem-solving strategies to interpret, clarify and develop responses to routine, simple problems in life-related situations</td>
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<td>use of data to synthesise mathematical models in simple situations and generation of data from mathematical models in simple through to complex situations.</td>
<td>use of mathematical models to represent routine, simple situations and generate data.</td>
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<td>• appropriate interpretation and use of mathematical terminology, symbols and conventions from simple through to complex and from routine through to non-routine, in life-related situations</td>
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<td>• analysis and translation of information from one representation to another in life-related situations from simple through to complex and from routine through to non-routine</td>
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<td>• use of mathematical reasoning to develop coherent, concise and logical sequences within a response from simple through to complex and in life-related situations using everyday and mathematical language</td>
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<td>• use of mathematical reasoning to develop sequences within a response in simple routine situations using everyday or mathematical language</td>
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<td>• coherent and logical justification of procedures, decisions and results.</td>
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<td>• justification of the reasonableness of results.</td>
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