

How does measurement apply to pigeons?

This article tells the story of one student who chooses her personal interest in pigeons and their lifestyle to demonstrate her understanding of measurement concepts. The student's work is used to consider the possibilities for assessment afforded by tasks designed within reform-based curricula.

Anita (pseudonym) was a Grade 6 student who was part of a research project investigating how classroom teachers are positioning numeracy in an emerging values-based curriculum setting and how this positioning influences student experiences of numeracy and their development of mathematical understanding. The motivation for the larger project is the reform-based curriculum in Tasmania, centred around five Essential Learnings: Thinking, Communicating, Personal Futures, Social Responsibility, and World Futures (Department of Education, Tasmania [DoE], 2002), and encouraging trans-disciplinary activities. Other Australian states and territories are also re-conceptualising curricula in terms of similar over-riding big ideas.

Alongside curriculum reform movements, conceptualisation of assessment has moved to a focus on assessment that is educative, formative, an integrated part of teaching and learning, and aimed at improving student performance. Wiggins (2003) discusses the challenges

for numeracy that these shifts pose and the need for tasks to reflect the actual practice of real-world problems in order for them to be realistic and provide evidence of students' abilities to use mathematics in varying and complicated situations. Making the boundaries between school and the world less distinct by bringing authentic contexts into the classroom still needs to be considered in terms of the effect these contexts might have on student learning (Anderson et al., 1996). This poses considerable challenges for the devising of assessment tasks in a trans-disciplinary framework and the need to assess multiple objectives within contextually rich tasks.

Of interest in Anita's case study is:

- exploration of the mathematical understanding demonstrated by her in a context chosen by her
- examination of the assessment opportunities that an open-ended mathematical inquiry provides

Learning context

Anita's teacher was implementing a unit of work entitled 'How do you measure up?' with the teaching, learning and assessment plan guided by goals in two of the Essential Learnings key element outcomes: 'Being numerate' (Communicating) and 'Inquiry' (Thinking).



Jane Skalicky tells the story of a girl's mathematical inquiry and the assessment opportunities it presented.

Being numerate. The DoE embraces a comprehensive view of numeracy.

Being numerate involves having those concepts and skills of mathematics that are required to meet the demands of everyday life. It includes having the capacity to select and use them appropriately in real settings. Being truly numerate requires the knowledge and disposition to think and act mathematically and the confidence and intuition to apply particular mathematical principles to everyday problems... (DoE, 2002a, p. 21)

Inquiry. The central Thinking Essential Learning brings the processes of inquiry and reflection to all questions and investigations. In particular, the aim of the 'Inquiry' key element is to develop the capacity of learners to pose problems, gather relevant information, consider possibilities, make decisions, and justify conclusions.

Effective learners need the capacity to ask good questions, persevere in a line of inquiry, be systematic, set goals, and plan and follow a course of action... The ability to communicate what has been learnt and thought about, and to do so in a consistent, coherent, relevant and persuasive way, is essential in enabling learners to participate fully in schools, communities and workplaces. (DoE, 2002a, p. 14)

It was within the broader goals of 'Inquiry' and 'Being numerate' that the twelve week unit of work was planned. During this time students undertook many activities and open-ended investigations building their mathematical skills and understandings particularly, but not solely, in relation to the measurement strand of 'Being numerate'. The goals for the unit of work were brought together in a culminating performance.

Culminating Performance

The task Anita completed is presented in Figure 1. The overriding aim of the task was to provide students with an opportunity to demonstrate an understanding of their learning in a context of their own choosing by posing a 'big' or 'rich' question to investigate. The students were provided not only with the task but also with the goals being addressed by the task.

Culminating Performance

Understanding Goals:

Being numerate – measurement:

1. What can be measured and how do we describe and communicate those measurements?
2. How can knowledge and understanding of measurement be used to answer questions about our world?

Inquiry Goals:

3. Understand how to pose and define a problem, clarify the issues involved and select and monitor the most effective process to use.
4. Be able to collect and record information, with an understanding of accuracy and reliable results.
5. Understand that reflective thinking is a deliberate process and that it is used to develop and refine ideas and beliefs and to explore different and new perceptions.

Open Investigation:

Thinking about all you have learned during our measurement unit, what are some of the BIG questions related to measurement that you may want to investigate?

You will need to consider:

- What makes a good question?
- What are some big issues in our world that relate to measurement?
- What would you like to find out more about?

Pose the problem, ask the question.

Conduct your investigation.

As you discover some possible or partial solutions to your question make a note of new questions you need to ask as they arise.

[Presentation format negotiated with the teacher]

Figure 1:
Culminating performance task

Table 1: Rubric for Culminating Performance

Assessment Criteria	Key areas for assessment (addressed across 4 levels of performance)	Essential Learning Key Element Outcome	Understanding Goal (from Task)
Questioning	Posing of relevant question and identifying problem	Inquiry	3
Investigating	Formulation of plan, accessing of sources, collection and judgment of relevant data, representation of data for purpose and audience	Inquiry	3 & 4
Can identify other issues arising	Identifying new problems and issues arising from investigation, and how these are addressed	Inquiry	5
Content	Measurement: understanding of relationships and standard units, how measurement is used to answer questions about our world, communication and justification of measurement understandings	Being Numerate	1 & 2
Presentation	Neatness and organisation of work, appropriateness of presentation for purpose and audience	Being Literate	Beyond task goals
Effort & Time Management	Quality and quantity of work in relation to time and effort.	Reflective Thinking	Beyond task goals

The assessment rubric for the task was collaboratively constructed by the teacher and her students. It included criteria relevant to the ‘Being numerate’ and ‘Inquiry’ goals declared for the task. Additional criteria for presentation, effort and time management were included and valued by both teacher and students. These criteria also contributed to the assessment of curriculum outcomes that were beyond the scope of the goals of the task. The rubric consisted of four levels of performance for each of the specified criteria (Appendix A). The aim of the rubric was to provide a clear set of criteria for students to refer to that would guide their progress and support the learning experience. Upon completion of the task students self-assessed their work prior to teacher assessment. Table 1 presents a modified version of the final rubric, describing how it was constructed in terms of its connection with both the Essential Learnings key elements and the understanding goals, which were a focus of the culminating performance.

Anita’s work

Anita presented her completed work in a coloured spiral bound book. The book had seven sections and these are described below with particular excerpts drawn from the work to demonstrate the issues being considered in this article: the situating of the measurement understandings in the context chosen and also the areas of opportunity for assessment.

1. Introduction to choosing the big question

Anita originally chose as her question: ‘Why do we have seven days in a week and why are there twelve months?’ She describes in this section where she took this investigation and that “despite my best efforts I couldn’t come up with a solution... So I had to come up with a new question.” Anita’s question became ‘How does measurement apply to pigeons and their lifestyle?’

2. My life around pigeons

Anita describes how she was introduced to pigeons by her grandfather and tells a story about her grandfather raising his own pigeons. She details her personal story of breeding and training pigeons.

I got my first four pigeons from my grandad when I was seven, the same age he got his. I started to breed and train them and soon after that my loft was too small to keep them all inside with enough room to move around. Dad brought me a new aviary, which is the one I have now ... In a few years I went from four pigeons to seventy-eight. It was hard but we had to get rid of some. I refused to let Dad dispose of them so I gave some away to my uncle... I got back down to twenty pigeons and then I had to stop breeding them so it wouldn’t all happen again... They never really went far away from home but then their numbers started creeping up again and I was only allowed to keep fifteen of them when we moved so I packed them into their racing boxes and my dad put them on the back of the work truck that was going up to Devonport. We did

that twice and ended up with only three of the ones we took. So altogether I had seventeen but I kept the extra two anyway.

3. My babi girl

Anita gives a very personal and emotive account in this section of her hand-reared pigeon 'Babi' and how Babi came to a tragic end.

This is the story of my bird, Babi ... Then one year two of my pigeons laid two eggs. I waited patiently for them to hatch and shortly after they did one of the hatchlings died. I felt sorry for the now single chick ... I watched her grow up and I put a small blue ring to tell who she was when she was flying ... One day I went down to the loft to see Babi and I found that she wasn't there ... That was when I realised that she hadn't been one of the escapees ... I got to the fence it was her. She was in the pond (which was empty) and her head was covered in blood. The flesh on her neck was gone ... I held out my arms and she ran into them. A hot burning sensation erupted on my cheeks. I was crying. I knew she would die... She was born in 2003 and only lived until 2004... One year later I have one minute silence on the 17th minute of the 17th hour of the 17th day in the 11th month (in other words 17 past 5 on the 17th of November)...

4. Training

In this section Anita writes about both the moral reasons for pigeon training and also the details of training itself. Anita describes her own method of pigeon training. She includes her own drawing of a pigeon loft and the design of the bolten wires (Figure 2) that enable the pigeons to fly back into their loft but not fly out.

Pigeon training is very important. Some people just have pigeons cooped up in a cage all day every day but that isn't right ... Training starts for young pigeons when they have all their feathers and are able to glide to the ground from a reasonable height. If they cannot then the long drop into the loft could result in a broken leg or wing. You hold the pigeon the correct way and walk around your yard in a large circle... Do as many circles as you like and then walk them to the

loft or aviary and then let them look on top of it. Push them through the bolten wires then let them go... Once a pigeon is trained you can start taking them to far away places and see if they come back. They must be able to fly at this stage though. Start off taking them a little way down the road so that it will probably take them less than a minute to get back just so that they get used to the idea. Each time take them a little bit further ...

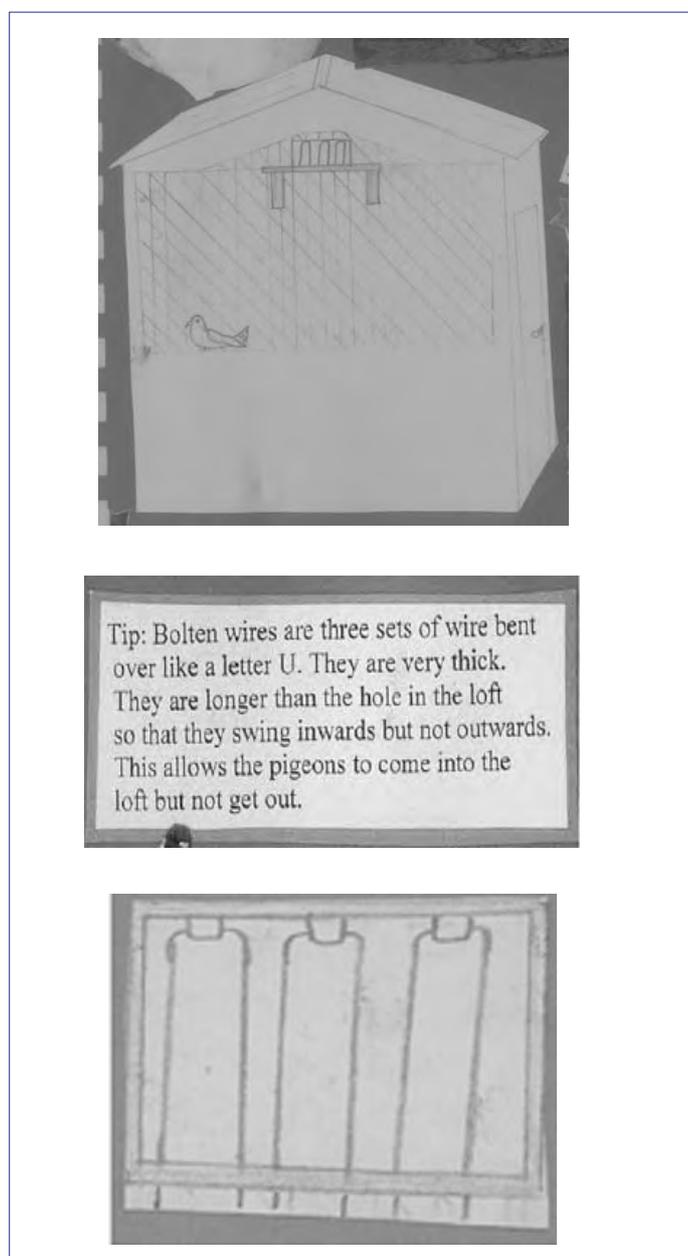


Figure 2: Anita's pigeon loft

5. Racing

The details of racing pigeons is the focus of this section, it introduces pigeon clubs, and how clocks are used in racing. Anita also describes two kinds of racing pigeons: the sprinter and the glider.

After pigeons are trained you can join a pigeon club. Pigeon clubs take pigeons to far away places to release them, this is known as a race. The first pigeon to return home and into its loft wins. ... They use clocks. These are no normal clocks. They are clocks that when the rubber racing ring a pigeon has on its leg is put into the clock it stops the timer... The night before the race all contestants go to the pigeon club and synchronise their clocks... There are two kinds of racing pigeons. Sprinters and gliders. Sprinters have lighter bones, longer feathers and a small build. This enables them to fly super fast over a short distance where as gliders have heavier bones, shorter, fatter feathers and are stockier than sprinters... When entering a race you must take the pigeons to your pigeon club on the scheduled night... The trucks used are divided into four parts. Two levels, higher and lower so as to fit more birds in... The driver then drives the pigeons to the releasing location and lets them all go at the same time. This is when the race has begun.

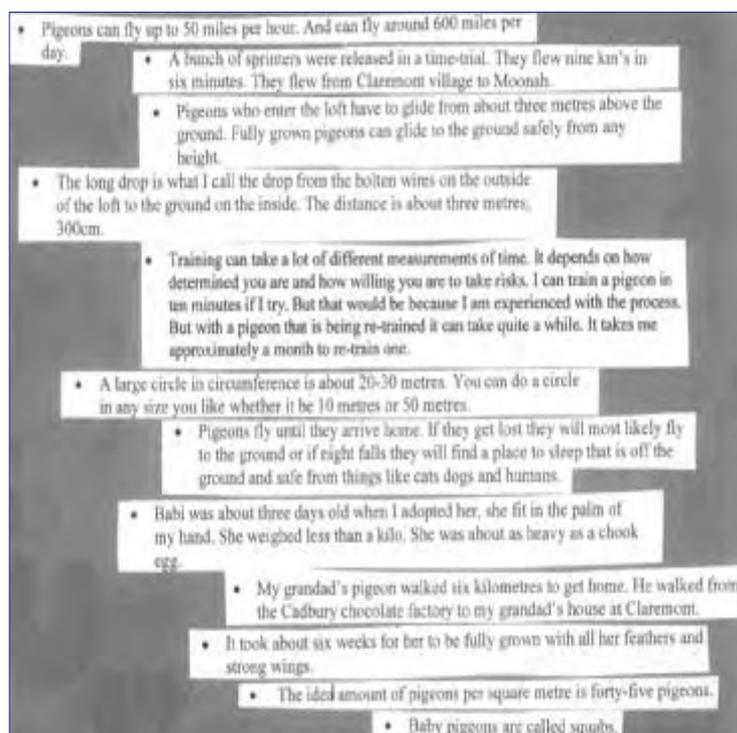


Figure 3: Measurement with pigeons

6. Life as a pigeon

Anita describes the life cycle of the pigeon in this section.

Pigeons only lay two eggs at a time. Pigeon eggs take about 18 weeks to hatch... It takes it about two - four days to peck away the whole egg. The babies are born with their eyes shut and they stay like that for about 5 days, sometimes a week. ... At about the age of two weeks I ring the babies. This is where I put a registered ring on their leg... Over the weeks the pigeon grows feathers and starts to become more independent. They still rely on their parents for food but occasionally try picking at it themselves... Soon the pigeon learns to fly and is trained to return home. This is when the fight for survival can begin... These pigeons miss the first molting season since their feathers are still new and unharmed. But when the next breeding season comes around they are old enough to lay their own eggs and the whole life cycle happens again. Fact: breeding season starts in September and finishes in March. That is when the molting season begins. Fact: pigeons live for around 20 years.

7. Measurement with pigeons

This final section includes a list of facts Anita draws together from the specific measurement aspects of a pigeon's lifestyle from her overall investigation. A sample of these is included in Figure 3.

How does Anita's work illustrate the objectives of studying her case?

Measurement understandings in context

There is much measurement embedded within Anita's investigation. It begins more incidentally within the story she is telling about her life with pigeons and becomes more specific as she describes the training regime of the birds including construction of the aviary, the competitive race information, and the pigeon's life cycle. Anita completes her work with a list of measurement-related facts to tie together some of the areas already included and fill some gaps that she identified in her previous sections. She demonstrates that although sometimes deeply involved in the story-telling she does

not forget the purpose of the task being to demonstrate her understanding of measurement as it applies to her question. Throughout the seven sections of Anita's pigeon investigation she demonstrates her understanding of the main 'big ideas' of measurement as informed by the national curriculum profile in mathematics for Australian schools – choosing units, measuring, estimating, time, and using relationships (Australian Education Council, 1994). These aspects of measurement were a focus of the twelve week unit of work leading up to the culminating performance task and Anita shows that she could transfer her understandings from the broader unit to a context of her own choosing. The incidental evidences of other mathematical topics—number, space, and chance and data—supports the value of the task in encouraging the connectedness of topics within mathematics itself and to contexts socially and culturally grounded in Anita's life.

Assessment opportunities

The assessment rubric designed for this task was predominantly a tool to support student learning and to enable students to self-assess their work. For the teacher, it contributed to her overall assessment of her students for the unit of work 'How do we measure up?' but was in no means a stand alone assessment tool. Spending twelve weeks observing the classroom enabled the formation of a total picture of the means by which students such as Anita were assessed. The teacher has realigned her pedagogical practices to suit the changing curriculum environment in which she works. She assessed in the three key ways espoused by Earl (2003) as making assessment 'an integral part of learning' (p. 21). Assessment for learning, having a formative emphasis, was utilised throughout the unit of work. She constantly kept observational records of the students using sticky notes, and used this to guide her teaching. She never sat at her desk; she walked the classroom interacting and questioning her students to stimulate their thinking, and assisting them to scaffold their learning. Assessment as learning is demonstrated by the use of the collaboratively designed rubric. It assisted students to identify their learning goals and enable them to self-monitor their work. Assessment of learning, occurred throughout the unit of work with the assessment of student artifacts. The culminating

performance enabled the teacher to tie together the assessment rubric with other forms of assessment into her final judgment concerning the placement of students against the pre-defined standards of the Essential Learnings curriculum.

The teacher did not anticipate the richness that the culminating performance offered her in terms of assessment opportunities. Beyond the criteria in the rubric, Anita's piece of work presented clear opportunities also to assess outcomes in the key element 'Being literate.' With respect to 'Being numerate', Anita's work could have been used to assess outcomes for other mathematical strands, additional to measurement, if required. When considering the mathematics involved in the many aspects of a pigeon's lifestyle that Anita discussed, evaluation of other learning outcomes of the wider Essential Learnings curriculum may also be possible. This is particularly relevant for World Futures, with Anita's work being related to 'Investigating the natural and constructed world' and 'Understanding systems', two key elements within this Essential Learning.

Concluding remarks

Anita's work provides an example of the possibilities for numeracy within reform-based curricula. She demonstrates her ability to evidence her mathematical understandings alongside her thinking in an environment where the process of student thinking about a problem is valued, not just the solution to it. This was made possible in this task by clearly stated goals assessed against pre-defined learning outcomes in addition to a teacher laterally looking at other evidences of understanding not initially intended. It became a piece of work that was a rich and valuable source of assessment.

Anita's case study has also shown that when our view of assessment is broadened to include consideration of the context of learning and how mathematics is applied within that context, then multiple opportunities to assess student learning are exposed. It also demonstrates the value of students using personal interests as meaningful opportunities for them to demonstrate their understanding of many aspects of the curriculum.

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ADMC

Appendix A: Assessment rubric for culminating performance

Criteria	Yes	Yes But...	No But...	No
Questioning	Has posed an Open-ended question with relevance to topic. Has clearly identified the problem	Has posed a relevant question but too big or too narrow.	Has attempted to pose a question but not relevant to topic. Unclear in purpose or intent.	Has not identified a question, problem or issue to be investigated.
Investigating	Formulated clear plan in order to proceed with investigation. Has accessed variety of sources. Has collected relevant data and had made judgments about the quality of information. Has selected best way to represent data for purpose and audience	Has a plan to proceed with investigation. Has accessed a couple of sources. Has collected data but has not made judgments about quality or relevance. Has not considered purpose and audience in representation of data.	Has a plan but has not followed it. Relied on one source of information. Not enough data collected to find a solution. Has not considered purpose and audience.	No plan formulated. Relied on one source. Data not relevant or evaluated for quality. No evidence of consideration given to audience or purpose.
Can identify other issues arising	Has clearly identified new problems and issues arising as the investigation proceeds. Has addressed those problems and issues.	Has identified new problems and issues arising but has not adequately addressed those problems and issues.	Has identified new problems and issues arising but has not attempted to address them.	No consideration given to new problems or issues as they arise.
Content	Has demonstrated understanding of measurement relationships and standard units of measurement. Has demonstrated understanding of how measurement can be used to answer questions about our world. Has justified and communicated understandings. Has provided a solution to original question or problem.	Has demonstrated some understanding of measurement relationships & units of measurement. Has demonstrated some understanding of how measurement can be used to answer questions about our world. Has not clearly communicated understanding and has not managed a clear solution.	Limited understanding of measurement relationships and units and has not connected measurement concepts to real world situations. Partial solution provided.	No understanding evident of measurement relationships or standard units of measurement. Has not addressed original question or problem.
Presentation	Neat, well organised used heading/sub-headings Appropriate presentation for purpose and audience	Neat and organised with some use of headings. Has not considered purpose and audience in presentation	Untidy in places with little organisation. Has not considered purpose and audience in presentation.	Untidy, difficult to read. Lacks organisation.
Effort & Time Management	Quality & quantity of work indicates a lot of time and effort.	Has done what was required but nothing over.	Quality & quantity indicates little time & effort. All areas lack care and detail.	Poor quality and too brief. All areas lack care & detail.