WHICH IS BIGGER? 250 TONNES OR 17%: A TALE OF SALT

JANE WATSON AND KIM BESWICK
University of Tasmania
Jane.Watson@utas.edu.au Kim.Beswick@utas.edu.au

The potential for Numeracy across the Curriculum is illustrated in this paper. Based on a newspaper article about salt in the Australian diet, two avenues of investigation are suggested. One is based on exploring the meaning and implications of the numbers in the article, using percent. The other involves data collection from a local supermarket and the software *TinkerPlots*.

Introduction

As the National Curriculum Board continues its deliberations on Australia's four initial curriculum areas – English, History, Science and Mathematics – it is to be hoped that the acknowledgement of the importance of "Numeracy across the Curriculum" as stated in the draft Mathematics document is translated across the other three subjects. In the initial drafts of the other three, only History acknowledged the importance of data to the study of the subject. As writers continue the task of creating the four curricula, it will be imperative for them to communicate and collaborate with each other on the important issue of Numeracy. In contemplating ways that mathematics educators can assist in this process, one way is to suggest organisers that can be used to structure curriculum development and a second is to provide down-to-earth relevant examples of how the organisers could work.

This paper suggests two organisers and provides a contextual example to illustrate how they can be developed for the classroom. The first organiser focuses on current affairs and the media. The use of newspaper and other media sources has been advocated for many years for the development of quantitative literacy skills and critical thinking (e.g., Watson, 1992; 1996; 2004). The suggested learning sequence for quantitative literacy is based on a three-tiered hierarchy that encompasses (i) understanding the mathematical terminology used in the extract, (ii) understanding how that terminology fits with and helps explain the context within which it is set, and (iii) thinking critically to understand the implications of claims and question those that do not have adequate justification. The potential for developing cross-curricular links based on current affairs is unlimited.

The second organiser is based on data. The information-laden 21st century presents opportunity at every turn to use data to study phenomena, answer questions, and question theories and claims. To be useful in the classroom, however, data require contexts and a suitable interface for analysis. One interface is the software *TinkerPlots* (Konold & Miller, 2005) and several examples of its application in middle school contexts illustrate its potential (Watson, 2008; Watson, Fitzallen, Creed, & Wilson, 2008; Watson & Wright, 2008). The *TinkerPlots* software was developed from a perspective of students creating representations suitable to the story they wish to tell rather than being constrained by fixed formats such as histograms or pie charts. It is possible that the context relevant for considering data is the same as that found in a media report. That is the case with the topic considered in this paper, *salt*.

Developing Quantitative Literacy

In February, 2009, *The Mercury* newspaper in Hobart published a report entitled "Salt-rich diet gets a lashing" (Rose, 2009). The story was syndicated through the AAP and many of the other newspapers across Australia carried similar stories. It was based mainly on a press release from the Australian Food and Grocery Council (AFGC). The complete text of the article is reproduced in Appendix A. A search of the web will show that the article reflects almost exactly the information from the press release. What are the opportunities offered by this article and topic for enhancing Numeracy across the Curriculum?

The salt content of food is a health issue for many people today. As is stated in the article, "People with a high-salt diet place themselves at risk of hypertension (high blood pressure), increasing the risk of heart disease in later life and, according to a recent Australian study, Alzheimer's." The cross-curriculum link to Health and Well-being is clear but also there is a link to Science due to the chemical makeup of salt. There are also issues of critical Literacy in relation to Media Studies and the question of why the AFGC would be putting out a press release on the topic. Given the range of numbers and measures presented in the article, there is great opportunity to develop and/or use Numeracy skills in understanding and interpreting the information in the article.

The most humorous sentence, which gave rise to the title of this paper is the following: "Smith's Classic Crinkle Cut Original Potato Chips now have 17 per cent less salt than in 2006, Unilever (maker of Flora margarine) has removed more than 250 tonnes of salt from their spreads, while Kellogg's has removed a similar amount from their breakfast cereals since 1997." Why would one turn from reporting a 17% reduction in salt to reporting a drop of 250 tonnes? Already at this point, without any need for calculations, critical thinking (Tier 3 of the hierarchy) comes to the fore. Joel Best (2008) in his book *Stat-spotting* suggests that people use different mathematical formats depending on which "will make the most powerful impression. Often, packaging statistics effectively means making a problem [or solution] seem as large as possible" (p. 65). Percentages can be impressive but perhaps the writer of the press release worried that 17% did not sound very large. As Best says, "absolute numbers may be preferable when percentages or proportions seem less impressive" (p. 65). Certainly for most people, 250 tonnes seems like a very large amount of salt. The question for the quantitatively literate student is, “how can we make a comparison of these two numbers?” The answer is, “we can’t because for example we don’t know the total number of tonnes of food produced by Unilever or Kellogg’s.” One feels that for both companies the number must be incredibly larger than 250 tonnes. A similar issue arises for Smith’s Chips if one wished to know how many tonnes of salt had been removed from its chips. The basic numeracy involved is about “parts and wholes” and without the “whole” both percentages and absolute numbers can be meaningless. In fact it could be that the 17% reduction in salt in Smith’s Chips is much more impressive than that of Unilever or Kellogg’s if 250 tonnes turns out to be 1% of their total tonnage of food production. By middle school, alarm bells should ring when students read sentences like this one in any curriculum area.

The sentence about Australians’ estimated salt consumption and recommendations, however, provides opportunities for gaining practice at calculating percents and applying percent understanding in context. Four fast food products are noted, each with the percentage of the recommended daily intake of salt that they contain. Since 4 grams is the recommended daily amount, students can be asked to calculate the number of grams of salt in each product, with answers ranging from 4 grams to 7.76 grams. These are quite easy calculations because they only require multiplication of 4 grams by the decimal equivalent of the percentage, e.g., 194% translates to 1.94. This follows because if 100% is equivalent to 1.0 in decimal form (in this case each representing the “whole” of 4 grams of salt), then using the proportion

$$\frac{100}{194} = \frac{1.0}{X}$$

leads to X = (1.0)(194)/(100)
= 1.94 .

The calculations become more interesting, however, if one were to consider the actual amount of salt in Vegemite or Smith’s Chips today and ask how much there was in 1974 or 2006. This requires data collection at a supermarket, where one finds that Vegemite today contains (in most jars) 3450 mg of sodium per 100 grams of Vegemite. Is sodium the same as salt? No, a gram of salt has 0.4 grams of sodium in it or for each mg of sodium in a product, there are 2.5 mg of salt. This can be confusing since all of the numbers in the article related to salt but products in the supermarket are labelled with sodium content. The 3450 mg of sodium per 100 g of Vegemite becomes (3450 × 2.5)/1000 grams of salt or 8.625 g of salt per 100 g of Vegemite; hence Vegemite is about 8.6% salt. If Vegemite has reduced its salt content by 13% since 1974, how much sodium (or salt) did it have per 100 grams in 1974? This problem is not as easy for some students to resolve. If 3450 mg is 87% of the 1974 sodium content per 100 g, then it is a matter of solving the proportion,

$$\frac{3450mg}{Xmg} = \frac{87}{100}$$

and

$$X = \frac{3450mg \times 100}{87} = 3966mg.$$

The same calculation can be done with 8.625 g of salt or the answer for sodium can be multiplied by 2.5/1000.[i] Either way, in 1974 there were 9.91 g of salt per 100 g of Vegemite or the product was nearly 10% salt.

Although one can look at the 8.6 g of salt in 100 g of Vegemite and be shocked that it is over twice the recommended intake per day, it is very unlikely that a person will indulge in a whole 100 g jar of Vegemite in a single day! Hence the normal serving size becomes an issue and some useful estimation problems can be devised for students in terms of how many grams of Vegemite they put on their toast in the morning. The issue of serving size is what raises alarm bells in relation to the fast food products discussed at the end of the newspaper article. Although one cannot imagine using up one's daily salt allowance on Vegemite, it is certainly possible with a single meal of one of these products.

In terms of the Numeracy involved related to percentage, two types of problems have arisen so far:

194% of 4 g = ☐

and 87% of ☐ = 3450 mg.

The first is usually solved by multiplication and the second by division after the percents are changed to decimals (e.g., .87) or fractions (e.g., 87/100). The third type of percentage problem arises if for example we have two measurements of sodium content for a product sold in "ordinary" and "salt-reduced" forms and wish to determine the percentage reduction for the salt-reduced product. Soy sauce for example is another high-salt content product and one company makes its usual product with 6510 mg of sodium per 100 g of soy sauce. The salt-reduced product contains 4010 mg of sodium per 100 g of soy sauce. What is the percentage reduction in sodium in the salt-reduced product? To answer this question requires two steps. First, the reduction must be calculated, 6510 mg – 4010 mg = 2500 mg. Second, the third type of percent question must be answered:

☐ % of 6510 mg = 2500 mg.

Using a proportion,

$$\frac{X}{100\%} = \frac{2500mg}{6510mg}$$

or X = 38.4%. The problem is usually thought of as a division problem but remembering it as a proportion can help some students by reinforcing the part-whole concept in this type of percent problem.

Data Collection and Analysis

Considering this last example about salt reduction opens up the possibility of students' collecting data from the supermarket for foods that are manufactured as "ordinary" products and as products with less salt. Students could be set the task of carefully defining the way data will be collected to be sure reductions are meaningful (for example, the brand and product name must be the same). After collecting the data, decisions need to be made as to what is important to enter in a software package for analysis. The *TinkerPlots* software provides a "data cards" format that lends itself to students beginning to enter data and deciding on attributes they wish to add later. Figure 1 shows two data cards for different products, where the salt reduction looks very different between the two. A plot of Original_Salt_Content vs Revised_Salt_Content (Figure 2) for 29 foods looks as if there may be different trends in some of the products. The tomato paste had "no added salt," whereas the chunky pasta sauce was only "salt reduced." Students may decide to add an attribute, Type_Reduction, to distinguish these two features in future analyses (see Figure 3). Clicking on this attribute colours the icons to produce Figure 4, which shows the difference between "no added salt" and "salt reduced" foods. Clicking on the one food that appears with the cluster of "salt reduced" products shows it is the "no added salt" dry roasted macadamias.

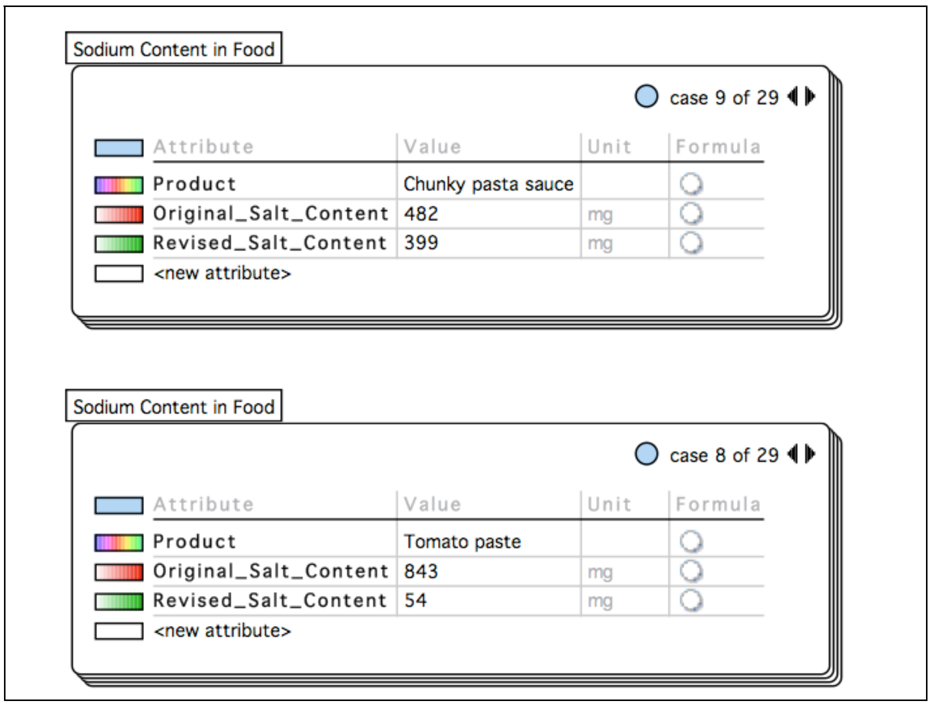

Figure 1. Data cards for two salt-reduced products.

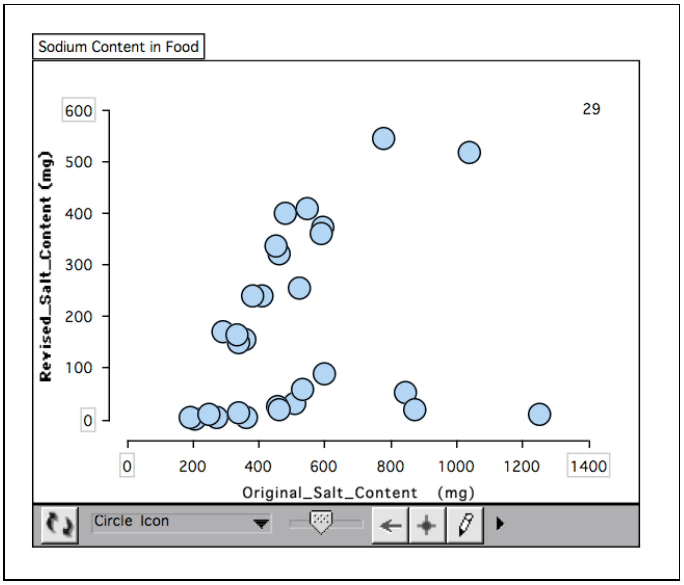

Figure 2. *Scatter graph of original and revised salt content of 29 foods.*

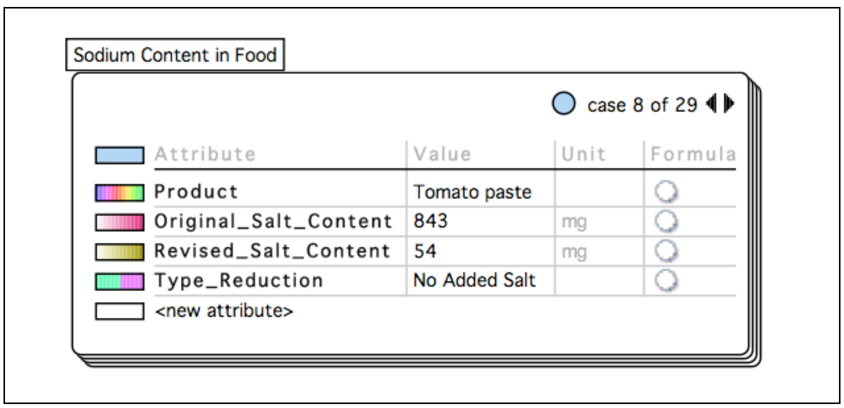

Figure 3. *Addition of a new attribute.*

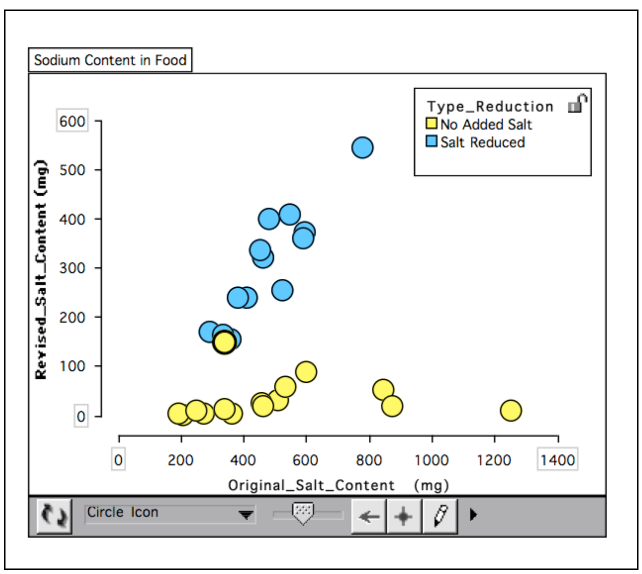

Figure 4. *Scatter graph colour-coded by type of salt reduction.*

Although Figure 4 shows two clusters of products related to the type of salt reduction, students can use their knowledge of percentage to define a new attribute Percent_Reduction to give this value for each food. Figure 5 shows how to define this attribute by clicking in the Formula column of the data card as shown on the left and choosing appropriate attributes from those listed in the formula box. The data card on the right shows the application of the formula to the product on the data card.

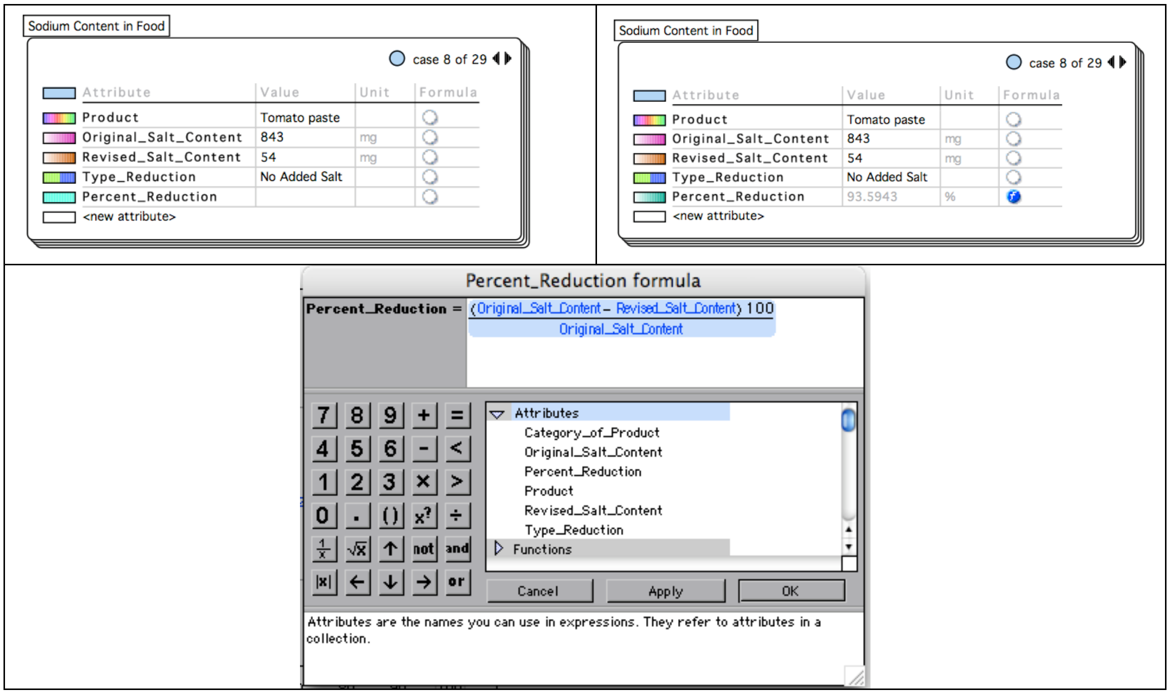

Figure 5. Defining the Percent_Reduction attribute.

Figure 6 shows a plot of the percentage reductions, coloured by Type_Reduction and Figure 7 shows the plot separated by the Type_Reduction attribute with the average percentage reduction for each type of food labelled. Such a representation may help students realise why it is important to read labels and distinguish between the two types of salt-reduced foods. It also should prompt them to question the information provided by the mean reduction in Figure 6, as this plot illustrates well a situation where the arithmetic mean is not a meaningful reflection of the data set.

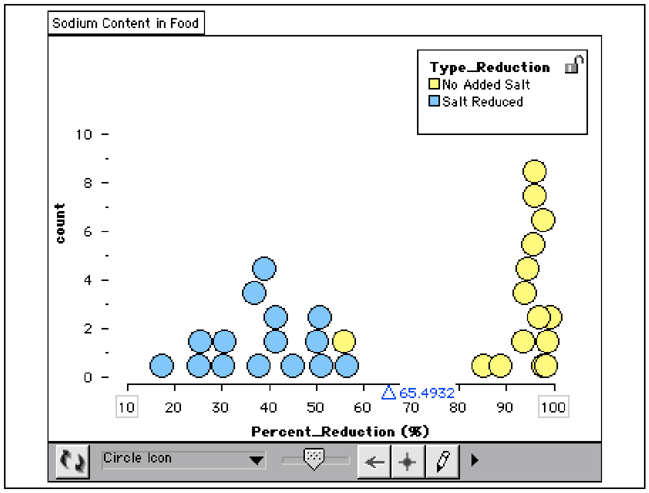

Figure 6. *Dot plot of percent reduction for 30 products.*

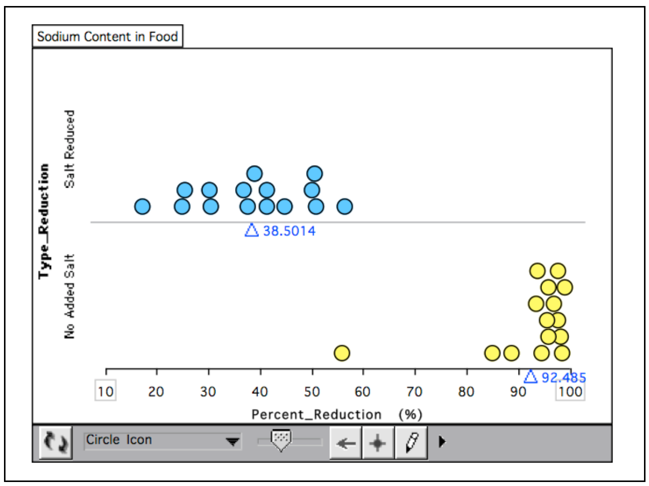

Figure 7. *Separated dot plot with mean percent reduction for the two types of salt reduction.*

Students might also consider whether some kinds of foods have one type of reduction or the other. The foods in the data set can also be categorised in five groups: Nuts, Sauce, Soup/stock, Spread, and Tinned Food. This allows a comparison across categories of foods based on original salt, reduced salt, percentage reduction, or type of reduction. Figure 8 shows the new attribute and Figures 9 and 10 show some comparisons that can be made. Sauces have the highest original salt content per 100 g of food and nuts the least. In the salt-reduced products (of both types) Soups and Stock are the highest whereas Nuts are still the lowest. Considering the percentage reduction attribute and colouring by Type_Reduction shows the influence of the two types on the mean value, as seen in Figure 10.

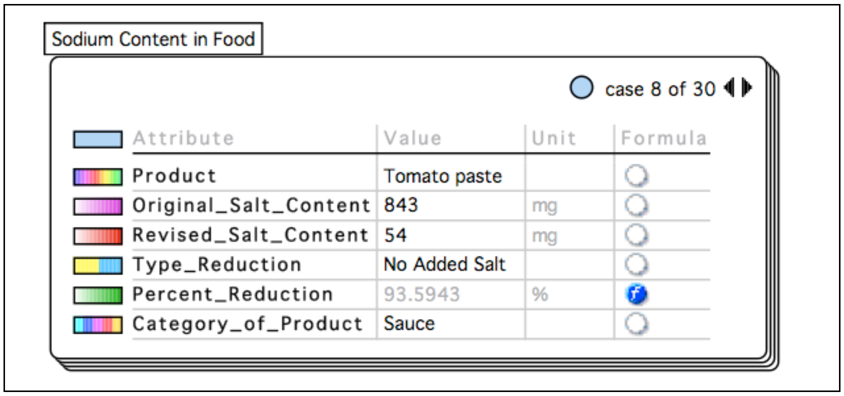

Figure 8. *Addition of a further attribute.*

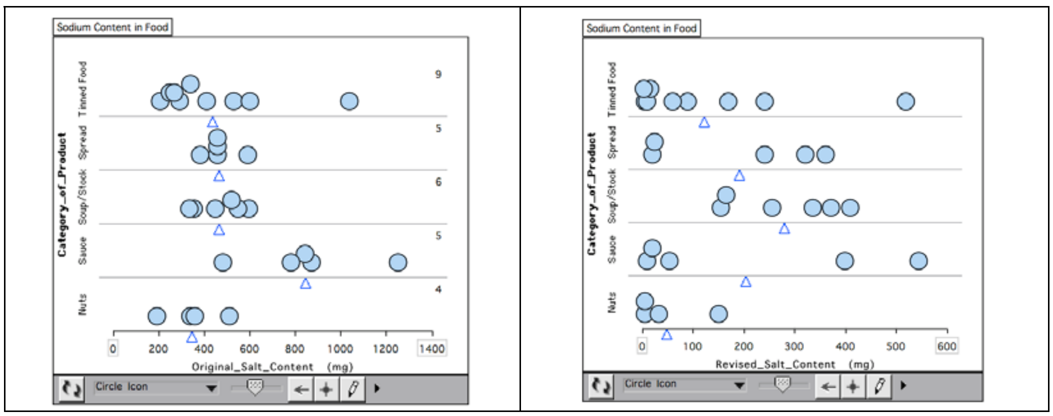

Figure 9. *Comparing Original and Revised salt content by Category_of_Product.*

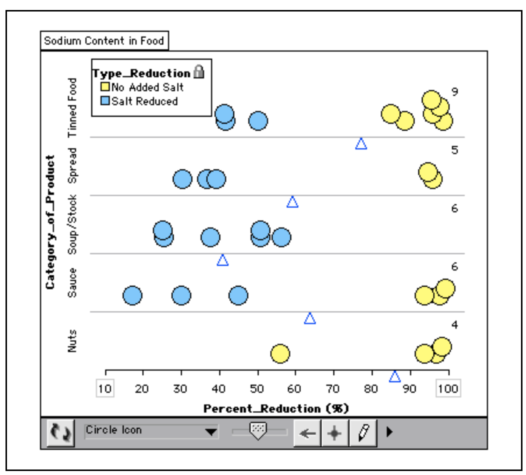

Figure 10. *Percent_Reduction by Category_of_Product.*

Soy sauce is an outlier in the data set in terms of salt content. Figure 11 shows its influence on the plots and means for the two salt content attributes. Soy sauce has been “hidden” on similar graphs shown earlier. In terms of percentage reduction, however, soy sauce is not an outlier, illustrating how important the distinction is between actual numbers and percentages. Its reduction of 44.8% is seen in the sauce row of Figure 10.

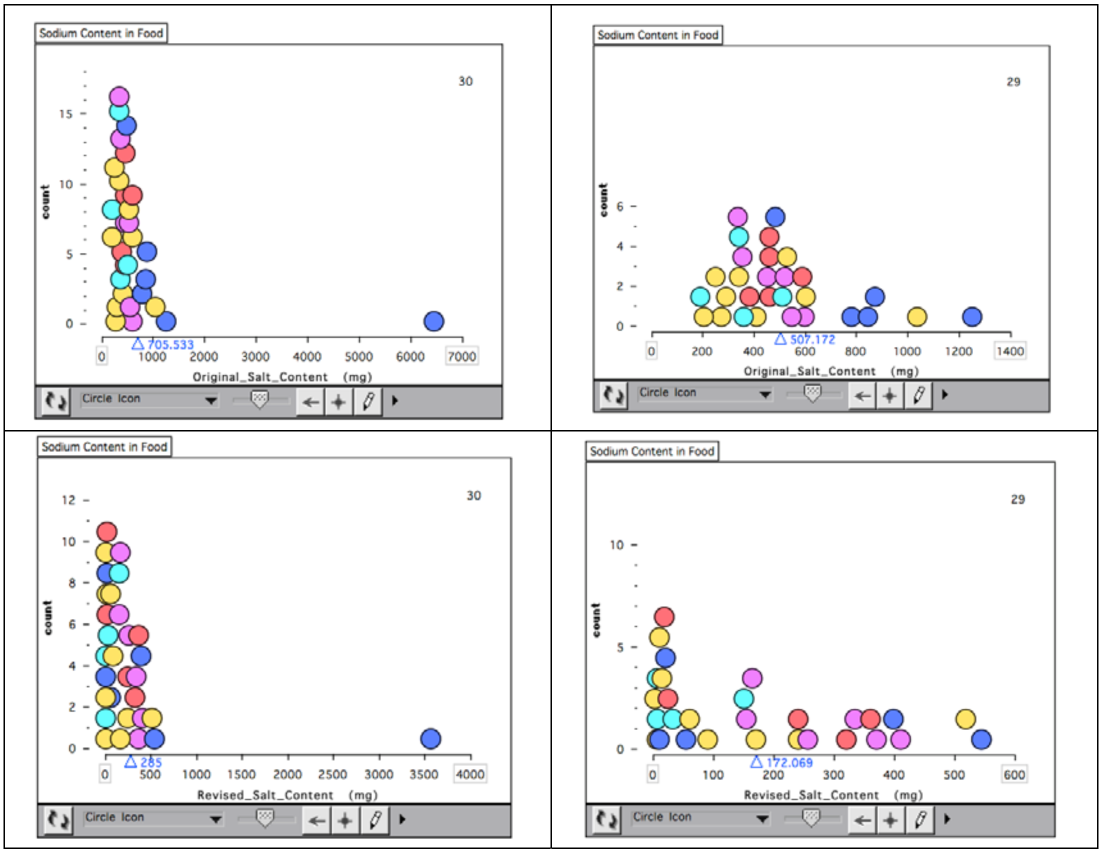

Figure 11. *The influence of soy sauce on mean Original_Salt_Content and mean Revised_Salt_Content.*

Returning to a question similar to the title of this paper, which is bigger, a reduction of sodium content of soy sauce by 44.8% or having 3560 mg per 100 g left? Which matters most to your health? To answer these questions requires the three tiers of quantitative literacy: (i) an understanding of percent, (ii) an understanding of the meaning of percent and percent reduction in the context of salt in food products, and (iii) critical thinking to make a decision about how this understanding will influence your eating habits.

Notes: The entire data set as collected for this paper is reproduced in Appendix B but it is more meaningful if students collect their own data. More information on salt and fast foods can be found in the AWASH report (The Secretariat of the Australian Division of World Action on Salt and Health, 2009).

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References

Best, J. (2008). *Stat-spotting: A field guide to identifying dubious data*. Berkeley, CA: University of California Press.

Konold, C., & Miller, C. D. (2005). *TinkerPlots: Dynamic data exploration*. [Computer software] Emeryville, CA: Key Curriculum Press.

Rose, D. (2009). Salt-rich diet gets a lashing (February 6). *The Mercury* (Hobart, Tasmania), p.15.

The Secretariat of the Australian Division of World Action on Salt and Health. (2009). *Drop the salt! AWASH fast food key findings, February 2009*. Sydney: The George Institute for International Health. Available at: http://www.awash.org.au/documents/AWASH_Fast_Food_Key_ Findings%20_February_2009.pdf

Watson, J. M. (1992). Fishy statistics. *Teaching Statistics*, *14*(3), 17-21.

Watson, J. M. (1996). What's the point? *Australian Mathematics Teacher*, *52*(2), 40-43.

Watson, J. M. (2004). Quantitative literacy in the media: An arena for problem solving. *Australian Mathematics Teacher*, *69*(1), 34-40.

Watson, J. (2008). Eye colour and reaction time: An opportunity for critical statistical reasoning. *Australian Mathematics Teacher*, *64*(3), 30-40.

Watson, J. M., Fitzallen, N. E., Wilson, K. G., & Creed, J. F. (2008). The representational value of hats. *Mathematics Teaching in the Middle School*, *14,* 4-10.

Watson, J., & Wright, S. (2008). Building informal inference with *TinkerPlots* in a measurement context. *Australian Mathematics Teacher*, *64*(4), 31-40.

Appendix A

Friday, February 6, 2009 *Mercury, p.15*

Salt-rich diet gets a lashing

DANNY ROSE

AUSTRALIA'S food and grocery industry has defended its record on salt in the wake of damning research that highlights unhealthy sodium levels found in everyday items.

The Australian Food and Grocery Council says the industry is doing its bit to educate people about a healthy diet, while food companies have been working quietly for years to cut salt from their products.

"Vegemite started reducing its salt content in 1974 — it now has 13 per cent less than the original recipe," says AFGC chief executive Kate Carnell.

"Smith's Classic Crinkle Cut Original Potato Chips now have 17 per cent less salt than in 2006, Unilever (maker of Flora margarine) has removed more than 250 tonnes of salt from their spreads, while Kellogg's has removed a similar amount from their breakfast cereals since 1997."

Current estimates are that Australians consume around nine grams of salt each day — well over the maximum of six grams and more than double the recommended four grams.

People with a high-salt diet place themselves at risk of hypertension (high blood pressure), increasing the risk of heart disease in later life and, according to a recent Australian study, Alzheimer's.

Ms Carnell said industry was also responding with the introduction of Daily Intake Guide labelling on the front of food packaging — a more user-friendly system than nutrition information boxes on the back of products.

"It is generally recognised that eating too much [salt] can contribute to high blood pressure and other illnesses," she said.

"That is why the food and beverage sector has long been working to educate consumers on how to better construct a more balanced diet."

Her comments follow the release of new research which shows how a person can exceed their recommended daily salt intake in just one meal at any of the major fast food outlets.

Subway's most salt-laden offering — a spicy Italian sub — came in at 100 per cent of the recommended daily intake, while a Classic Half Chicken meal from Red Rooster topped the list at almost double (194 per cent).

KFC's Zinger Double BBQ Bacon and Cheese Burger with large chips provides 191 per cent, followed by Hungry Jacks Whopper Double Beef and Cheese burger plus onion rings and a large chocolate shake (153 per cent).

AAP

Appendix B

Product	Original_Salt _Content	Revised_Salt _Content	Type_ Reduction	Percent_ Reduction	Category_ of_Product
Fountain Tomato Sauce	871	20	No Added Salt	97.7038	Sauce
Rosella Tomato Sauce	1250	10	No Added Salt	99.2	Sauce
Soy Sauce	6458	3560	Salt Reduced	44.8746	Sauce
Tinned tomatoes	270	6	No Added Salt	97.7778	Tinned Food
Four Bean mix	250	10	No Added Salt	96	Tinned Food
Corn kernels	205	3	No Added Salt	98.5366	Tinned Food
Mushrooms (tinned)	340	15	No Added Salt	95.5882	Tinned Food
Tomato paste	843	54	No Added Salt	93.5943	Sauce
Chunky pasta sauce	482	399	Salt Reduced	17.2199	Sauce
Chicken stock	521	256	Salt Reduced	50.8637	Soup/Stock
Beef stock	450	335	Salt Reduced	25.5556	Soup/Stock
Peanuts	360	6	No Added Salt	98.3333	Nuts
Beef strogonoff mix	780	545	Salt Reduced	30.1282	Sauce
Dry roasted macadamias	340	150	No Added Salt	55.8824	Nuts
Cashews	510	32	No Added Salt	93.7255	Nuts
Butter	460	320	Salt Reduced	30.4348	Spread
Sunflower spread	380	240	Salt Reduced	36.8421	Spread
Baked beans	290	170	Salt Reduced	41.3793	Tinned Food
Peanut butter	458	25	No Added Salt	94.5415	Spread
French Onion Soup	335	165	Salt Reduced	50.7463	Soup/Stock
Chicken Noodle Soup	355	155	Salt Reduced	56.338	Soup/Stock
Meadowlea Original	590	360	Salt Reduced	38.9831	Spread
Butter	460	19	No Added Salt	95.8696	Spread
Pink Salmon	600	90	No Added Salt	85	Tinned Food
Gravox Supreme	595	371	Salt Reduced	37.6471	Soup/Stock
Vegetable stock	547	410	Salt Reduced	25.0457	Soup/Stock
Spam	1036	518	Salt Reduced	50	Tinned Food
Spagetti	410	240	Salt Reduced	41.4634	Tinned Food
Mixed nuts w green pistachios	190	6	No Added Salt	96.8421	Nuts
Red Salmon	530	60	No Added Salt	88.6792	Tinned Food

[i] Another way to solve the problem is to think of the percent values and use decimals:
0.87 of X is 8.6%
i.e., 0.87 × X = 8.6%
so

$$X = \frac{8.6\%}{0.87} = 9.9\%.$$