QUANTITATIVE LITERACY INTERVENTION IN THE FACULTY OF HEALTH SCIENCES FOR MEDICAL STUDENTS AT THE UNIVERSITY OF CAPE TOWN

Sheena Rughubar-Reddy
Numeracy Centre
University of Cape Town
Sheena.Rughubar-Reddy@uct.ac.za

This article examines some aspects of the effectiveness of a first-year course in quantitative literacy for medical students at a South African university. As many students do not have the necessary foundations of mathematical and statistical knowledge and skills, the interventions are intended to provide 'foundations' in terms of quantitative literacy. Since quantitative literacy is a practice embedded in the disciplinary practices, this intervention has been integrated into the disciplinary curriculum. While this supports the argument that student motivation to engage with a context-driven curriculum is dependent on their interest in and perception of the relevance of the content and contexts used, the intervention could be enhanced by being more explicit in clarifying the distinctions between the disciplinary contexts and the mathematical and statistical content, as well integrating technology into the curriculum and creating opportunities for students to become involved in data collection on small research projects.

INTRODUCTION

Many South African students are poorly prepared to meet the quantitative literacy requirements in university curricula (Frith & Prince, 2009). Conventional mathematics does not adequately prepare students for the quantitative literacy demands of their university curricula or their personal and vocational lives. Quantitative Literacy (QL), on the other hand, promotes the types of vital mathematical and critical thinking skills needed to live a more informed, proactive life (Wiest, Higgins & Frost, 2007, Mhakure, Jaftha & Rughubar-Reddy, 2014).

Interventions to reduce the "articulation gap" (Scott, Yeld & Henry, 2005:273) between the curricula demands and the level of many students' quantitative literacies need to be instituted (Frith, 2012). Hence, the QL courses for first year medical students at the University of Cape Town were primarily designed to equip students with the essential foundations of mathematical and statistical knowledge and skills to satisfy the quantitative reasoning demands of their studies in higher education. Teaching in higher education in a post-apartheid South Africa has raised new questions and possibilities about educating students for effective citizenship.

I will begin by discussing what it means to be quantitatively literate and describe the context of the course described in this article. I will then consider some observations regarding the implementation of the course curriculum and factors that limit its effectiveness in achieving our curriculum goals.

WHAT DOES IT MEAN TO BE QUANTITATIVELY LITERATE?

At the Numeracy Centre at the University of Cape Town, we conceptualize quantitative literacy as practices imbedded in particular social (and academic disciplinary) contexts (Frith et al., 2010). I maintain that a quantitatively literate student is important for creating a more effectively functioning society. Furthermore, it is also a matter of preparing individuals to function as informed global citizens using quantitative information as a key analytical tool. While sensitizing students to the extensive social problems in our country (Frith et al., 2010), we ought to enable them to acquire the knowledge, attitudes, and skills needed to act to make both the nation and the world more democratic and just (Banks, 2004). Therefore, teaching of quantitative literacy with its embedded social justice agenda aims to achieve this by making students more aware of their environment (Jablonka, 2003) and providing them with "a critical awareness that builds bridges

In: J. Engel (Ed.), *Promoting understanding of statistics about society.*
Proceedings of the Roundtable Conference of the International Association of Statistics Education (IASE), July 2016, Berlin, Germany. iase-web.org/Conference_Proceedings.php

between mathematics and the real world" (Johnston, 2007, p. 54, Mhakure, Jaftha & Rughubar-Reddy, 2014).

Accordingly, I subscribe to the following definition as adopted by the Numeracy Centre:

> Quantitative literacy (numeracy) is the ability to manage situations or solve problems in practice, and involves responding to quantitative (mathematical and statistical) information that may be presented verbally, graphically, in tabular or symbolic form; it requires the activation of a range of enabling knowledge, behaviours and processes and it can be observed when it is expressed in the form of a communication, in written, oral or visual mode (Frith and Prince 2006, 30).

The definition of numerate behaviour underlying the assessment of numeracy in the Adult Literacy and Lifeskills (ALL) Survey (Gal, van Groenestijn, Manly, Schmitt & Tout 2005) and the view of literacy as social practice strongly influenced the development of this definition. The view on what a student needs to be able to do in order to practise quantitative literacy as suggested by Frith and Prince (2009), is adopted by the Numeracy Centre.

THE QUANTITATIVE LITERACY COURSE FOR MEDICAL STUDENTS

First year students who perform poorly overall in their mid-year examination are supported by a year-long intervention programme to develop the necessary competencies to cope with the demands of the MBChB curriculum. They return to semester 2 of the MBChB programme a year later. During the second semester (for the year under discussion) 27 students on the intervention programme attended the eleven 90 minute-long workshops.

A workshop generally comprises a mixture of the following: input by the lecturer (either discussing new work or giving feedback on homework), opportunity for students to work in groups on activities (allowing for collaboration, discussion and obtaining assistance from the lecturer) and whole class discussion for questions that pose difficulty in general.

The course has the general objectives, namely that students should be able to:

- Read text, tables and graphs containing quantitative information critically and with understanding;
- Express quantitative information in clear English, using tables and graphical representations where appropriate, and
- Construct arguments, using data and statistics to support claims.

Frith and Gunston (2011) analysed the mathematical and statistical content in the first-year medical curriculum with the aim to inform the design of quantitative literacy interventions thereby reducing the gap between the demands of the curricula and students' quantitative/statistical literacy competencies. To address the integration of the QL provision into the medical curriculum context-based learning materials that develop students' quantitative practices within disciplinary contexts (associated with the public health component of the course) were developed. Thus the quantitative literacy provision provides support for each of the cases studied in the problem-based learning curriculum. Consequently the content for the quantitative literacy in the intervention program is therefore designed to support that of the first-year MBChB programme.

The learning materials for the QL provision consist of worksheets that are a combination of resource materials, explanatory notes and exercises for all first-year medical students. Resource materials are either full research reports or edited extracts from research reports within the medical disciplinary contexts. These are supported by compulsory weekly workshops during which students are assisted in making sense of the quantitative information presented in the course material. This affords students the opportunity to engage with substantial real contexts, real-world data. There is a

two-fold reasoning behind this: (i) it more closely mimics the reality of the quantitative literacy quantitative competencies.

The content of the course comprises of: (i) data represented in text, tables and charts; (ii) ratio, rates, direct proportion, percentages and percentage change; (iii) probability, measures of association, risk ratio and odds ratio, correlation and linear regression analysis; and (iv) confidence intervals, *p*-values, hypothesis testing and data collection. These are embedded in the contexts of childhood mortality rates, incidence and prevalence of disease, burns, diarrhoea, tuberculosis, risk-taking behaviour, hypertension and heart disease.

An example of the material used in the above course:

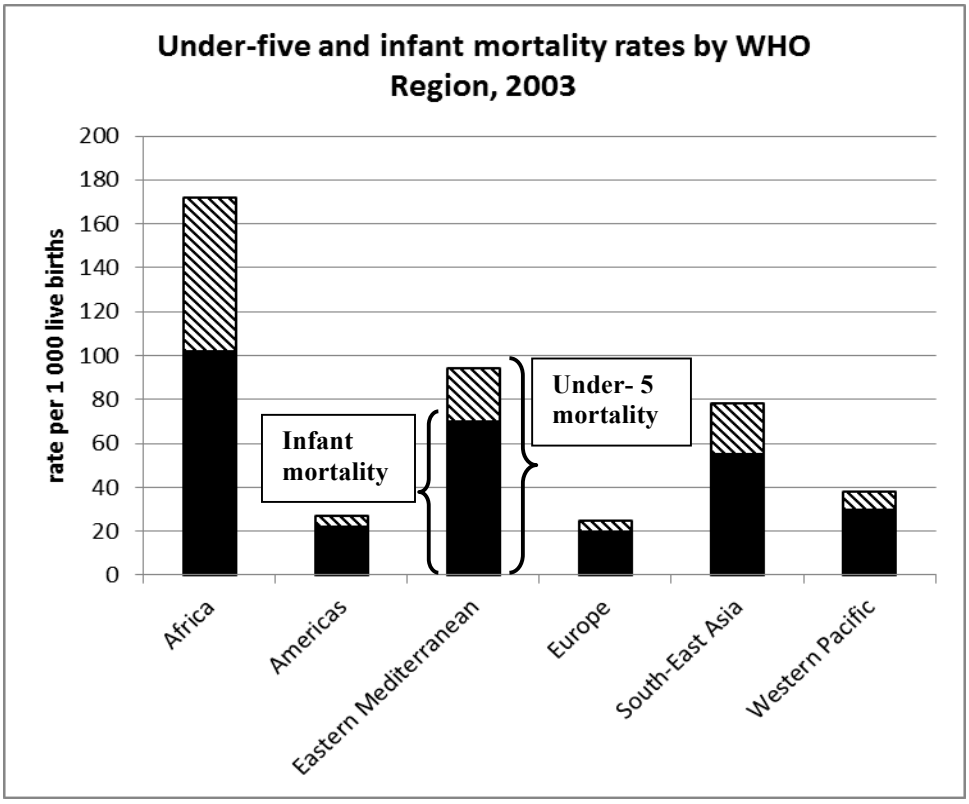

Figure 1: Under-5 and infant mortality rates

Given the chart, students answer questions on the data to establish their understanding of the statistical concepts. For example: (i) Use the graph to determine the under-five mortality rate and the infant mortality rate for Africa in 2003; (ii) Write these rates in terms of probability; (iii) Explain in words how the under-five mortality rate would have been calculated; and (iv) Compare the under-5 and infant mortality rates for Africa, with the other five regions.

Further examples may be found in the Appendix.

THE EFFECTIVENESS AND LIMITATIONS OF THE COURSE

In order to gain insight into the implementation of the curriculum for the quantitative literacy course described earlier, in particular the context-based first part, the following kinds of data were collected. A selection of classroom sessions was observed. At the end of the course, while focus group interviews were conducted with a group of students, all the students had to complete a course evaluation survey. The discussion that follows deals with some of the themes arising from these observations, in particular those relating to difficulties experienced as a result of the tensions that arose between the contexts and the mathematical and statistical content in teaching and learning.

Despite the QL intervention having its merits, teaching of the course also posed some challenges. First, for many of the students English is not their first language. As stated earlier, language forms an integral part of the quantitative literacy discourse. Quantitative information and concepts are conveyed through precise terminology, everyday words with very specific meaning related to the context. The issue of language becomes compounded for a student whose first language is not English. Students who took the time to write out answers rather than verbalise them appeared to have a better understanding of the quantitative/statistical issues. They were also able to rectify their errors and improve on their responses by reading what they had written. Being able to have discussions, created the space for students to communicate in their first language to tease out ideas and clarify concepts.

Secondly, school mathematics curricula generally stress abstract procedures. Most students were therefore able to plug in values into a formula and do the calculations. However, when students were required to use the data to develop critical arguments, or explain in words, for example, how the under-five mortality rate would have been calculated, some of them found it difficult to recognise the value in the exercise. Again, the issue of language and the inability to use the precise terminology became a stumbling block. Having students use the format of a formula but replacing numbers with words describing the numbers helped students understand concepts such as the under-five mortality rate.

Even though I judged that the contexts used as *real* life, my experience in the classroom revealed that I had unrealistic expectations of what students as perceived as 'real'. Not all students, however, have first-hand experience with such data or such contexts. Despite finding the research studies interesting, some students apparently engaged superficially with them. This lack of enthusiasm to engage with the contexts may be attributed to the fact that the understanding of the contexts is not considered to be the main focus of the course. As quantitative literacy constitutes only a small part of the assessment, it may be construed by students as irrelevant. Some students consider the workshops as preparation for assessments rather than a support structure for their learning, as evidenced by the comment "*The workshops are excellent in teaching us about how to answer the questions correctly*".

The results of the students' evaluation of the workshops reveal that students' responses to the QL intervention are generally positive. While 67% of the students indicated that they felt confident about dealing with quantitative/mathematical problems and information before the start of the intervention, all students stated that they felt confident about dealing with these issues at the end of the intervention. Comments to the question on whether they would recommend the course were: "*I would recommend these sessions to students as they were helpful with understanding the course work";* "*They assisted me with my other courses such as Public Health"* and *"They are relevant to us as future health professionals".*

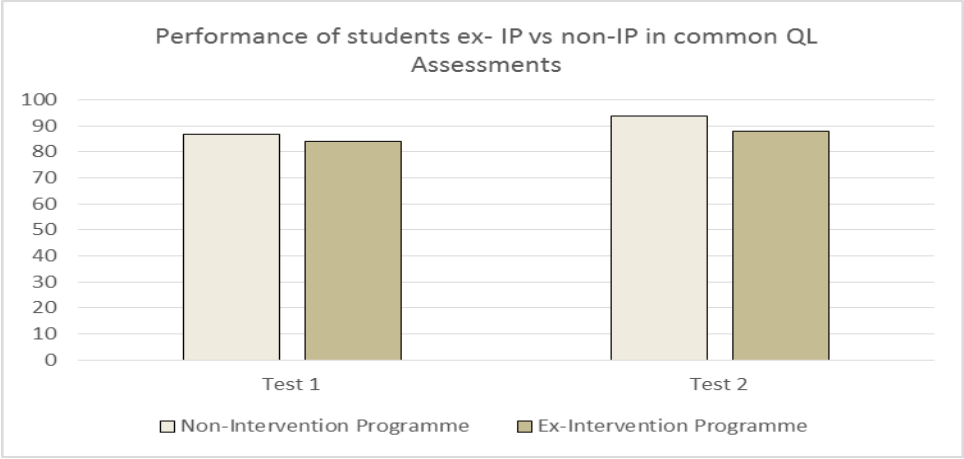

Figure 2: Student performance in QL assessments

Figure 2 shows the comparison of the results at the end of the1st year of the MBChB programme for the students who attended these workshops (Ex-Intervention Programme) with those who did not (Non--Intervention Programme) provides evidence that the workshops are indeed effective in terms of improving students' performance on the assessment questions. The difference between the means of the two distributions is statistically significant at the level above 99% (using a *t*-test).

CONCLUSION

This discussion is based on the lecturer's reflections on the teaching experience and on student evaluations. It is my perception that the students value the quantitative literacy intervention highly. This may be attributed to a combination of the fact that the contexts used in the medical intervention are the same students study concurrently in their other courses, together with the privilege of having small classes, hence more individualized attention.

Nonetheless there are some changes that may be implemented to address some of the issues that I have identified:

- Concentrate more on explicitly on developing students' ability to use and understand quantitative language in the context.
- Create opportunities for students to become involved in data collection in small research projects. This will help to make the contexts and dataset real and meaningful for the student.
- Introduce technology into the curriculum. As quantitative literacy often involves a degree of computer literacy, integrating technology into the curriculum will allow students to experience the data in different ways.

ACKNOWLEDGEMENT

My participation at The International Association for Statistical Education 2016 Roundtable Conference was enabled/supported by a joint grant from the World Bank Trust Fund for Statistical Capacity Building, International Statistical Institute, and the International Association for Statistical Education. However, the views expressed are my own and not those of the funding agencies.

REFERENCES

Banks, A. J. (2004). Teaching for Social Justice, Diversity, and Citizenship in a Global World. *The Educational Forum*, 68, 289-298.

Frith, V. (2012). A quantitative literacy course for Humanities and Law students: The challenges of a context-based curriculum. *Perspectives in Education*, 30(2), 41-49.

Frith, V. & Gunston, G. (2011). Towards understanding the quantitative literacy demands of a first-year medical curriculum. *African Journal of Health Professions Education*, 3(1), 19-23.

Frith, V., Le Roux, K., Lloyd, P., Jaftha, J., Mhakure, D., & Rughubar-Reddy, S. (2010). Tensions between Context and Content in a Quantitative Literacy course at University. In U. Gellert, E. Jablonka & C. Morgan (Eds.), *Proceedings of the Sixth International Mathematics Education and Society Conference* (pp.259-269). Berlin: Freie Universität Berlin.

Frith, V. & Prince, R.N. (2009). A framework for understanding the quantitative literacy demands of higher education. *South African Journal of Higher Education*, 23(1):83-97.

Gal, I., van Groenestijn, M., Manly, M., Schmitt, M.J., & Tout, D. (2005). Adult numeracy and its assessment in the ALL Survey: A conceptual framework and pilot results. In T. Scott Murray, Y. Clermont, & M. Binkley (Eds.), *International adult literacy survey. Measuring adult literacy and life skills: New frameworks for assessment.* Statistics Canada. Ottawa, Canada. Retrieved July 16, 2015, from http://www.nald.ca/fulltext/measlit/measlit.pdf

Mhakure, D., Jaftha, J., & Rughubar-Reddy, S. (2014). The Contribution of Course Materials to a Social Justice Agenda: Lessons from a Quantitative Literacy Course for Undergraduate Social Science Students. *Mediterranean Journal of Social Sciences*, 5 (23), 1190-1197.

Scott, I., Yeld, N. & Hendry, J. (2007). *Higher Education Monitor No. 6: A case for improving teaching and learning in South African higher education*. Pretoria: The Council on Higher Education. Retrieved on 18 October 2015 from: http://download.che.ac.za/documents/d000155/HE_Monitor_6_ITLS_Oct2007.pdf

Wiest, L. R., Higgins, H. J., & Frost, J. H. (2007). Quantitative Literacy for Social Justice. *Equity and Excellence in Education*, 40, 47-55.

APPENDIX

Example 1:

The table below is from the preliminary report of the 2003 *South African Demographic and Health Survey.*
Refer to section on Education in the table. Write down two to three points that describe how the TB prevalence changes with education level in South Africa in 2003. Why do you think it follows this trend?

Table 10.9 Prevalence and incidence of TB among adults

Percentage of participants who reported that they had been told by a doctor or nurse or staff member at a hospital or clinic that they had tuberculosis, the annual incidence rate (/100,000) and the average number of attacks according to background characteristics, South Africa 1998.

	Men			Men with TB			Women			Women with TB		
Background characteristic	Preva-lence	Inci-dence	Number	Mean number of attacks	SD	Total number of attacks	Preva-lence	Inci-dence	Number	Mean number of attacks	SD	Total number of attacks
Age												
15 - 24	0.8	386	1,812	*	*	14	1.1	312	2,080	(2.8)	(2.0)	25
25 - 34	2.1	565	1,120	*	*	23	1.8	429	1,716	(1.6)	(1.2)	28
35 - 44	4.1	747	1,003	(4.9)	(4.9)	34	2.0	149	1,454	(4.3)	(5.1)	28
45 - 54	5.2	420	700	(2.6)	(2.1)	28	2.6	400	1,113	(1.6)	(1.6)	28
55 - 64	4.1	227	514	*	*	20	2.2	342	914	*	*	18
65+	4.4	407	502	*	*	22	3.1	684	861	*	*	24
Residence												
Urban	2.6	408	3,569	3.7	3.9	81	1.6	294	4,999	2.4	2.6	73
Non-urban	3.3	594	2,102	3.3	3.0	59	2.6	469	3,157	2.7	3.1	76
Province												
Western Cape	3.2	562	721	*	*	16	2.3	311	799	*	*	16
Eastern Cape	5.8	1113	758	(2.3)	(1.5)	39	4.3	1026	1,161	(2.0)	(1.6)	49
Northern Cape	3.2	350	135	*	*	4	2.9	429	168	*	*	5
Free State	2.6	544	444	*	*	11	1.9	314	519	*	*	10
KwaZulu Natal	3.7	670	1,064	(5.8)	(6.2)	34	1.9	377	1,608	(4.2)	(6.7)	28
North West	1.2	168	551	*	*	6	1.3	430	647	*	*	9
Gauteng	1.7	0	1,099	*	*	16	1.1	140	1,887	*	*	19
Mpumalanga	2.1	343	378	*	*	8	1.9	255	507	*	*	8
Northern	1.8	446	521	*	*	6	1.1	0	857	*	*	7
Education												
No education	5.8	542	562	(3.7)	(3.0)	27	2.8	418	1,186	(2.8)	(2.6)	30
Sub A - Std 3	5.0	867	777	(3.6)	(3.4)	36	3.5	933	1,088	(3.1)	(4.1)	34
Std 4 - Std 5	3.5	995	755	*	*	21	2.2	693	1,136	*	*	24
Std 6 - Std 9	2.2	316	2,297	(3.7)	(4.3)	42	1.6	179	3,094	(2.5)	(2.5)	46
Std 10	1.5	313	801	*	*	10	1.0	89	1,120	*	*	10
Higher	0.4	0	440	*	*	2	0.7	0	495	*	*	4
Population Group												
African	3.0	549	4,257	3.8	3.7	110	2.0	408	6,269	2.7	3.0	116
Afr. urban	2.8	480	2,375	4.1	4.1	60	1.5	362	3,349	2.7	2.4	50
Afr. non-urban	3.3	637	1,882	3.5	3.1	50	2.5	459	2,921	2.8	3.3	67
Coloured	4.5	575	637	*	*	21	3.3	368	806	*	*	22
White	0.7	0	564	*	*	4	1.3	0	767	*	*	10
Asian	2.4	0	195	*	*	5	0.3	334	300	*	*	1
Total	2.9	477	5,671	3.5	3.5	140	2.0	362	8,156	2.6	2.9	149

Note: Parenthesis indicate that a figure is based on 25-49 respondents.
An asterisk indicates that a figure is based on fewer than 25 unweighted cases and has been suppressed.

Example 2:

Chart 1 below illustrates the prevalence of hypertension amongst adults in South Africa according to their income (adapted from Steyn *et al*). Use the chart to answer the questions below.

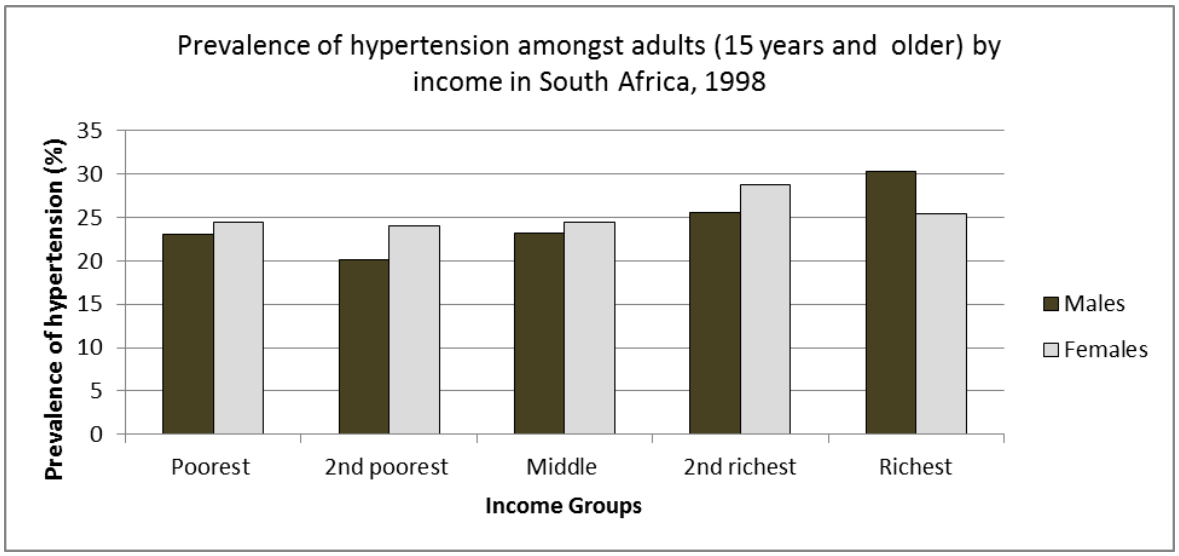

Chart 1: Prevalence of hypertension amongst adults in South Africa, 1998

(a) Compare, by income groups, the prevalence of hypertension amongst the participants in the study. Use data to support your answer.

(b) In 1998, the SADHS reported the mortality rate due to hypertension for 55-64 year olds in South Africa was 44.8 per 100000, while the size of the country's population was 41.9 million. Calculate the total number of people aged 55-64 years that died as a result of hypertension in 1998.