MAKING STATISTICS RELEVANT FOR UNDERGRADUATE NURSES ®

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In this paper we will explore the challenge of making statistics more meaningful to future nurses. In the fast moving undergraduate student world the expectations we place upon nursing students are considerable. Typically they experience high class-contact hours in addition to their clinical placements. Compounding the problem, undergraduate nursing students have diverse mathematical backgrounds and seldom perceive statistics as being relevant for them. Given these constraints we have adopted the relatively modest aim of producing informed and discriminating consumers of statistics and research, rather than skilled statistical practitioners or researchers. With a focus on computer output rather than by-hand calculations, we have made use of strategic examples, appropriate journal articles and an historical hypothetical. This approach has both relieved the anxiety and distraction associated with calculations and increased students' engagement in the learning process.

INTRODUCTION

Florence Nightingale may have been recognised as both a founder of the traditions of the nursing profession and social statistics (Cohen, 1984) but our undergraduate nurses seldom expect the two skills to be linked. They commonly lack motivation and interest in gaining statistical skills and understanding. Despite our best efforts (detailed below) student feedback in 2000 showed that while almost all students gave positive feedback about course structure, organisation and presentation, a significant minority, 38%, felt that their statistics course was too difficult and would not be useful to them in their course or profession. In 2001, in response to this negative reaction we decided to try to engage more students in the learning process through the use of a hypothetical based on the Reverend John Snow's famous work in identifying the cause of a cholera epidemic. This novel approach will be described in detail below but first the context of this experimental teaching will be outlined.

STUDENT BACKGROUND

In 2001 there were 128 students enrolled in our nursing statistics course. Of this group 77% were female and 23% male. About half the group were classified as 'mature aged' students and more than one third of students had not studied a mathematics subject in year 12. It was not surprising that many students exhibited anxiety when faced with the prospect of studying statistics. In addition students in this nursing degree program spend some weeks on campus and others doing clinical placements in hospitals. This means that to complete their academic program their 'on campus' weeks are quite demanding. Most of the students (77%) reported that they had at least 18 hours of classes during each week on campus and were expected to spend a further 36 hours out of class working on their subjects.

COURSE BACKGROUND

This is a 'service' course taught by statisticians for the school of nursing. The school of nursing has determined the broad topics to be covered and the organizational structure, while the details of teaching are left to the statisticians. Within the constraints imposed on us those teaching the course have taken an 'action research' style approach to improving our teaching and the learning outcomes of the students. This has involved monitoring the course with student surveys, discussion with students and nursing staff; then reflection followed by innovations which are then monitored the following year. Our current brief is to teach quantitative research methods to students who are in their second year of a three year nursing degree program. The course, developed by the statistics staff in consultation with nursing staff, involves 36 contact hours over 9 weeks of a 13 week semester. The course is structured as 2 one-hour lectures (full group) and 2 hours of tutorials (to groups of 15) per week. Teaching weeks are not all consecutive but interrupted by blocks of clinical placements.

The statistical topics covered range from descriptive statistics to one-way ANOVA. Computer output is used extensively in place of by-hand computations. This has allowed us to focus on choosing appropriate statistical methods, interpretation of computer output and practical applications of fundamental statistical principles. Appreciation and interpretation of statistics in nursing/health science journal articles is a strong feature of the course material. Over time we have built up a set of journal articles appropriate for the students' abilities and experiences. Students are asked to interpret the study objectives, explain the experimental design, the nature of the data collected, the reported statistics and any associated graphs and tables, etc. Interpretations in the context of the study are strongly encouraged. Rather than producing skilled statistical practitioners our objective is to produce informed and discriminating consumers of statistics and research (Pierce & Roberts, 1998).

RATIONALE FOR CHANGE

At the end of 2000 the course was reviewed in the usual manner, which involved course evaluation surveys, consultation with staff from the School of Nursing and discussions of the reflections of staff involved in the teaching of the program. From this review several key factors were identified as adversely affecting student attitudes and learning outcomes. These included anxiety and lack of engagement with respect to the learning process, and a perceived lack of relevance of statistics to both their personal lives and the nursing profession. Staff from the School of Nursing expressed concern at the negative attitudes and anxieties expressed to them by a number of their students. Staff teaching the course expressed disappointment that student discussion still focused upon the surface issues of statistical processes and seldom on the deeper issues involved in experimental design and interpretation of outcomes. To address these concerns we decided to use a 'hypothetical' as the basis of our approach in 2001. This allowed us to build a simplified context for the course based upon a real event in medical history. We decided to spend time discussing the context and the raw data in order to build an experiential foundation that would allow the students to make sensible statistical interpretations.

A NEW STRATEGY: THE HYPOTHETICAL

A fictitious data set was generated based on historical facts surrounding the work of the Reverend John Snow in London during cholera outbreak of the 1850's. We restricted our focus to the Lambeth area of London in 1854. The data set contained 10 variables: gender, name, street, age, height, weight, occupation, income, number of live births, and symptoms. We used six street names selected from the Lambeth area of an 1859 map of London (Frerichs, url). The ages were calculated based on average life expectancies of the period (Government Actuary's Department UK, URL). A sample character sheet is shown in Figure 1.

Name:	*Alice Walker*
Address:	*East St*
Age:	*32*
Gender:	*F*
Height (cm):	*136*
Weight (kg):	*46*
Occupation:	*Textiles*
Annual Income:	*$5,373*
No. of live births:	*5*
Complaints:	*Sunken Eyes, blue lips, diorrhea*

Figure 1: Sample Character Sheet

Heights and weights were generated using normal distributions according to age, gender and period. Occupations and incomes were based upon a table of average wages paid in 1851 (Williamson, 1982). Each female over the age of 18 was assigned a number of live births between 0 and 11. Each character was assigned up to three conditions which could be symptomatic of the disease cholera.

Each student and staff member in the course received a character sheet which then became their 'alter ego' for the semester. To enhance the realistic nature of the hypothetical, time was spent in both lectures and tutorials discussing the living conditions and demographics of the 1854 group. This proved successful in engaging students in using descriptive statistics. Teaching staff were pleased to see students comparing their 'alter ego' with those of others and with the summary statistics for the group. For example, some students who felt their 'alter ego' was earning a low wage, soon realized that in the overall context they were better off than most. In lectures and tutorials students were sometimes required to actively participate by taking on the role of their 'alter ego'.

Once the attributes of the hypothetical population were established student interest was seen to increase. One of the objectives of the hypothetical was to use the fictitious data set to provide a basis for lecture materials. For example, in a lecture on one sample t-tests the following research question was posed: Are late 20th century people taller than people from the 1850's? Animated discussion followed regarding an appropriate sampling frame. The students decided to restrict the sample to adult males. Having selected a sample it was decided to compare the sample mean against the currently published average male height using a one sample t-test. The most satisfying part of the process, from a teaching point of view, was the discussion involving the sampling procedure. Students were thinking not only of the appropriate test to use, but also of the context within which it would be used. Following this initial success the data set was used to explore a number of scenarios.

The culmination of these occurred when the actual work of Dr John Snow was presented in the lectures (Korner, 1996). Dr John Snow was a pioneer in epidemiology. From carefully recorded data he identified an association between polluted water sources and the frequency of cholera cases. In the first lecture of the week students were asked to sit in specific areas according to the street in which their 'alter ego' lived. Once students were seated they were informed that a cholera epidemic was sweeping through Lambeth and that many of them were very sick and possibly at death's door. For the remainder of the lecture time students were encouraged to discuss and attempt to demonstrate a possible cause of the epidemic. While they did this, pre-selected 'alter egos' with cholera symptoms died from their disease and those students were brought to a 'mortuary' at the front of the room. Interspersed with these deaths were slides which illuminated both the 1850's view of cholera and the sanitary conditions of the time. Almost all of the students were eager to solve the problem in any number of weird and wonderful ways. The most interesting point was that while many students realized there was a relationship between the street they lived in and their chances of dying, it took 40 minutes before anyone suggested tabulating the number of deaths by street. The resulting table was then used in the second lecture to demonstrate chi-squared tests of association. The most valuable learning outcome from the first lecture was the insight gained into how simple statistical techniques can be used to solve extremely chaotic and important real world problems.

RESULTS AND DISCUSSION

Students were surveyed at the beginning of the course and it was found that 54% expected to find the statistics course more difficult than their other nursing courses. Students were asked to respond to a number of statements about their expectations of the usefulness of the course by using a conventional 5-point Likert scale. A sample of statements and student responses is shown in Table 1. It seems that while only a minority of students expected statistics to be useful for their course, or profession, a majority recognised its value for understanding research.

Table 1. *Sample Statements (Wise, 1985) Reflecting Perceived Usefulness of Statistics and the Percentage of Student Responses for Three Categories*

	Collapsed responses		
Sample Statements	Negative	Neutral	Positive
I feel that statistics will be useful to me in my profession	14	49	37
I have difficulty seeing how statistics relates to my field of study	29	35	35
My statistical training will help me better understand the research done in my field of study	6	32	62

All staff involved in teaching the course reported a high level of student discussion, both in and out of scheduled classes, related to the hypotheticals. Initially their interest was centred around the demographics of the group. Many questions were asked of the lecturer with regard to wages, occupations and numbers of births. Most of these questions took the general form "Am I a high earner?", "Would a brewer have been provided with lodgings/food/beer etc…?". Later in the semester students began to ask much more complex questions such as "Couldn't there be other reasons, apart from water supplier, that lead to a link between cholera incidence and address?" It was the nature of the change in their questions that led us to believe there had been a shift in the way they were understanding statistics.

Previous experiences in the environmental sciences (Kentish, 1995, Taylor 1983) suggest that effective learning results are more likely to occur from using hypotheticals if participants are permitted to identify with specific roles, the mood of the situation is effectively captured and there is a distinction made between description and conceptualization of the situation. In order to determine whether this occurred with this group of students we obtained further feedback from them at the end of the semester. Their reflective comments suggested that their experience concurred with that predicted by Kentish and Taylor. They found it helpful and fun to identify with a hypothetical character but suggested this could have been given greater emphasis throughout the program. We compared the assessment results of the students from 2000 and 2001 to see if there were any significant differences that could be attributed to the hypotheticals. A summary of our findings is given below.

Assessment for this unit comprises two assignments (30% and 35%) and an examination (35%). This procedure was followed in both 2000 and 2001. To measure potential differences between the students over both years we controlled as many variables as possible. The same course material, structure, staffing and method of delivery was used in both years. By keeping the two assignments identical for both years we were able to gauge the difference between the students. Unfortunately we were not able to use identical final examinations for both years. Table 2 below summarises the assessment results for both years.

Table 2
Mean Scores (%'Ages) for Assessment Tasks in 2000 and 2001

Year	Assignment 1	Assignment 2	Final Exam
2000	73.7	68.2	69.6
2001	71.1	70.2	59.5
p-values	0.30	0.08	0.00

While the difference between the two groups of students was not significant with respect to the assignments ($p = 0.30$ and 0.08) we were disappointed to see the significant decrease in the final examination scores ($p = 0.00$). This is an issue we feel is worthy of further analysis in 2002.

At the end of the course the students were again surveyed using the same questionnaire as that used at the beginning of the course. This second survey took place immediately after the students had returned from a three week clinical placement. A comparison of their responses reflecting perceived usefulness of statistics is given in Table 3 below. We were disappointed to note the apparent decline in the perceived usefulness of statistics. This may possibly reflect the effect of work undertaken during their recent clinical placements.

Table 3
Sample Statements (Wise, 1985) Reflecting Perceived Usefulness of Statistics and the Percentage of Student Responses for Three Categories before (B) and after (A) the Course

Sample Statements	Collapsed responses					
	Negative		Neutral		Positive	
	B	A	B	A	B	A
I feel that statistics will be useful to me in my profession	14	32	49	48	37	20
I have difficulty seeing how statistics relates to my field of study	29	14	35	36	35	50
My statistical training will help me better understand the research done in my field of study	6	14	32	27	62	59

As usual we obtained student evaluations of the unit during the last week of lectures. It requested feedback regarding the way in which the unit was conducted, the structure of the unit, and the impact and nature of the content of the unit. We also took the opportunity to ask the students some open ended questions regarding our use of the hypothetical in this unit. We were particularly interested in whether or not the hypothetical helped or hindered their understanding of statistics. Their responses were analysed and are summarized below. Samples of students statements from the course evaluation are included in Table 4.

Of the 70 students surveyed 86% responded to the open ended questions regarding our use of the hypothetical. Of these responses 50% were positive, 37% negative and 13% were a mixture of both positive and negative comments. The majority of those responding positively (90%) provided reasons for the way they felt, whereas for those responding negatively only 32% (7 out of 22) provided a reason for their feelings. The positive comments typically included such points as more interesting, more real, more relevant, better understanding and more fun. Two students mentioned that hypotheticals were an excellent tool to enhance learning. The negative comments specifically mentioned the speed of the course and the failure of the hypothetical to link with the course material.

Table 4
Sample Statements from Student Course Evaluation

Did having a hypothetical character help you make sense of the material covered?	*How did the hypothetical help your understanding.*	*How did the hypothetical hinder your understanding.*	*Other comments*
No	Showed how outliers could effect data.	Spent a whole class sitting on the floor when I could have been doing things	It was too hard, I tried my hardest but struggled. It stressed me out because I couldn't do it.
No not really. At times it was very rushed which made it difficult for me to understand the theory behind the hypothetical characters.	At the beginning the hypothetical situations helped me to understand basic concepts of qualitative, quantitative, normal distribution and confidence intervals	At times I got confused with all the jargon related to these characters	I enjoyed the two assignments
Yes, excellent way to unfold concepts related to snippets or information received along the way	Relate real people and situations to concepts; Personalise material in interesting and involving way	None	- I enjoyed this unit greatly - Style, content and flow of material well thought out and very engaging - Friendly, open 2-way discussion between students and staff.
Yes, I suppose it made it fun for once	I was able to put myself in this situation and see how statistics are utilised	It just did	Not bad, I don't think that I have yet grasped the more complicated areas of this component. But with a bit of study I hope to do alright
No using the hypothetical I found didn't link theory with practice for me. There was no coming together of information b/w lectures and tutes for me.	Understood variables; graphs etc helped	Confused me	Wasn't as bad as I first thought
Yes allowed to relate to the worked examples and made information relevant to me	Made data presented relevant and helped to grasp concepts	Wasn't familiar enough with character, had to keep referring back to the sheet	Statistics was not my favourite in high school but I really enjoyed this unit

We were pleased to learn from the School of Nursing staff that in 2001 there were no complaints or issues from their students regarding the statistics unit. In addition they reported an apparent positive flow on to other nursing units requiring research concepts.

CONCLUSION

Overall the students' comments were very encouraging particularly given that we could not show a positive quantitative difference that we might attribute to our hypothetical. Whilst the majority of students were able say something positive about the use of the hypothetical their attitudes regarding the perceived usefulness of statistics hardened significantly. There was some concern at the timing of the second survey, as well as students' ability to fully comprehend their own responses to the negatively worded items on the attitude survey questionnaire. From our

observations and comments made by the students we feel there are several improvements that could be made, and the positive student feedback encourages us to try and further develop this teaching approach. Further discussions with students suggested that we make more effective use of the hypothetical by giving it greater emphasis, and provide more structured treatment in both lectures and tutorials. While not reflected in a quantitative manner, staff involved in teaching the unit reported deeper levels of questioning by the students in both lectures and tutorials.

In conclusion, we feel we have succeeded in making statistics more relevant and realistic for these students by engaging them in the hypothetical. The assessment tasks considered showed no differences with respect to the assignments however there was evidence of a decline in final examination scores of the 2001 students over those enrolled in 2000. We believe this should not be attributed to the hypothetical due to the possible effects of other factors that were not controlled in this study. The survey data indicates that we were not able to change student attitudes toward the positive regarding perceived usefulness of statistics for nurses, and the difficulty of statistics. In fact the data showed a significant hardening of student attitudes in both areas. This has given us much food for thought and will also be further investigated.

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