The impact of misunderstanding the nature of statistics

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STATISTICS is one of the most common topics across disciplines and levels of study (Blumberg, 2001). This is mainly due to a rise in need for students to apply analytical skills in almost any academic area (Garfield et al., 2001) or profession (Bakker et al., 2004). The statistical component of academic programmes is considered critical, and it is listed as one – if not the – focal point of higher education (Garfield et al., 2002).

Lessons learned by researchers in the teaching of statistics reveal much about the variety of obstacles faced by lecturers and students, such as statistics anxiety, negative attitudes, deficits in maths backgrounds, and expectations (Ruggeri, 2009). To this end, Batanero (2004) expressed the need for continued work on identifying and addressing these problems explicitly. This particularly included distinguishing statistics from maths and learning more about the nature of issues in statistics education across disciplines.

Statistics is a unique subject in any curriculum and requires a distinct way of thinking (Ben-Zvi & Garfield, 2004). While listing a variety of goals within a statistics course, Blalock (1987) noted from experience in teaching that learning statistics is not merely being able to memorise and regurgitate formulae, but to truly be able to implement critical quantitative skills to solve real problems. From this first-person account, it is apparent that this is not necessarily simple, as statistics – like mathematics – is a language, which means its vocabulary and rules must be applied to be useful (Conners et al., 1998). Because statistics is taught across many disciplines, there is not a single way of determining exactly which concepts are most relevant in any classroom (Wilson, 1997), much like a language and its many dialects and vernaculars. However, at a very minimum, covering the general nature of statistics and its application to study is still fundamental.

In a much earlier paper on statistics education, Caine et al. (1978) contest that how statistics is taught must vary because students' motivation may change based on their discipline. For students on a course where statistics is not considered requisite (e.g. education, political science), the motivation from the perspective of the student may be simply to demonstrate additional skills when applying for postgraduate courses and work.

Statistics is a vital portion of the psychology programme both in the UK and globally (Blumberg, 2001). Quantitative skills play such a pivotal role in students succeeding in a psychology degree and thus advancing into skilled professions, that the way statistics is taught and integrated into any course has been – and continues to be – a key area of research (Batanero, 2004). But, as Baloglu (2003) clearly shows, the extensive issues students report in learning statistics suggests more than it merely being a difficult subject.

Common goals from published work on teaching statistics classes include overcoming obstacles presented by anxieties, beliefs, and negative attitudes toward statistics (Schau, 2003). A limited but growing amount of work has been done to confront each of these (e.g. Baloglu, 2003; Onwuegbuzie, 2004) and characterise the affect on learning and applying ways to address problems in teaching statistics. The available literature clearly indicates that this may be the most important aspect of statistics education on which research should focus but as this work will show, that idea – and all those listed above – may perhaps overlook a central flaw in even introducing students to statistics.

The following results were selected from a comprehensive series of studies of statistics education in undergraduate psychology. The main focus of the overarching study was to determine the nature of statistics anxiety and attitudes toward statistics by using multiple measurements and analyses. While there were considerable gains in understanding, it was perhaps the simplest questions that provided the best insight.

Method

Participants

All participants were first-year undergraduate psychology students enrolled in an undergraduate psychology course in Northern Ireland. Only participants who completed each collection were included in the analysis (Table 1).

Instrument

The full measure was comprised of the Statistics Anxiety Rating Scale (Cruise & Wilkins, 1980) and the Survey of Attitudes Toward Statistics (Schau et al., 1995). Additionally, various questions relating to student backgrounds and expectations were included to explore assumptions made in previous research. However, for the purpose of this study, results relate only to three questions on how students compared statistics to other topics in psychology: 'How useful/difficult/enjoyable, do you think, is the statistics part of the psychology curriculum to other topics in psychology?' In the first instance, the question was worded 'will be' and in the first two instances, cognitive psychology, individual differences and perception were listed as examples of other topics.

Procedure

Questionnaires were distributed to first-year students at the beginning of compulsory laboratory classes. Collection dates coincided with specific aspects of the first year: before any statistics had been undertaken, after the first statistics assignment, at the beginning of the new term, and before the final exam. A detailed breakdown of what topics had been taught previous to each collection, is provided in Table 2. Students were given no time limit in which to complete the survey and it took on average between 12 and 15 minutes to finish.

Table 1: Participant demographics by collection.

	Mean Age	*Male*	*Female*
Collection 1	19.97	33	113
Collection 2	20.2	34	114
Collection 3	20.46	27	97
Collection 4	20.66	29	96

Table 2: Topics covered before and during test collections.

Collection	*Term-Week (of 12)*	*Subjects previously covered*
1	1–4	None*
2	1–11	Central Tendency, Correlation, Chi-Square, Group Comparison, Repeated Measures
3	2–1	Inference
4	2–11	*T*-tests, ANOVA, Experimental Design

*Specific previous experience was not collected.

Results

Over the course of the first academic year, there is some change in student perceptions of statistics (see Figure 1). The most immediately visible change is the decrease in statistics enjoy-ability between the first and second collections, and this lower score is maintained for the remainder of the year.

Friedman tests showed neither the perception of statistics as being useful nor difficult changed significantly during the year. Usefulness was rated generally at the median of the one-to-five scale, while difficulty was consistently higher at all points. Enjoyment of statistics, compared to other parts of the psychology course, varied significantly ($\chi^2(3,84)=134.59$, $p<.001$), especially when comparing subsequent collections to the baseline results.

Discussion

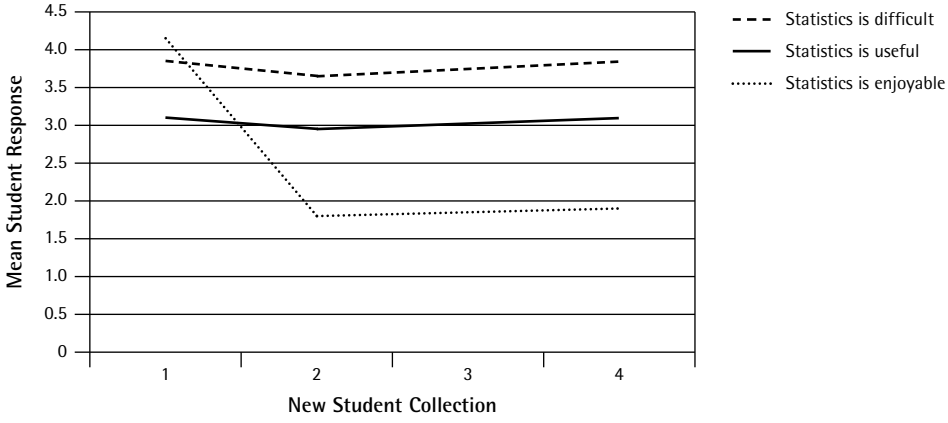
A first impression of the results may be simply that students do not enjoy the actual learning of statistics in university. Whether that was related to the subject, the teaching, the assessment, or a combination of those and other factors may be worth addressing but alone, it is hardly a surprising finding. When considering these results more thoroughly, though, much more is gained.

First, to have such a dramatically consistent drop in the enjoyment level, it seems unlikely that students had ever interacted with any discernable amount of statistics in their education. Had this been the case, such change would have been so improbable that, unless some particular aspect (e.g. teaching) was excessively poor, initial expectations would not have been so thoroughly unmet. Also, to anticipate such a high level of enjoyment out of anything only to in turn have essentially the opposite experience indicates students were not generally even aware of the real nature of the subject. These two concepts are not mutually exclusive and likely are collectively responsible, though the second is the more problematic.

If students – who were presumably high performers in school and committed to their studies enough to pursue tertiary degrees – do not accurately understand even the purpose of statistics, it likely represents a larger obstacle. Potentially, that represents a false perception most people have of not only the subject but the entire use of statistics.

In that mainstream information is so heavily filled with so-called statistical information in the form of means, percentages, and raw data, a distortion occurs with the way real statistics are viewed. This may not be

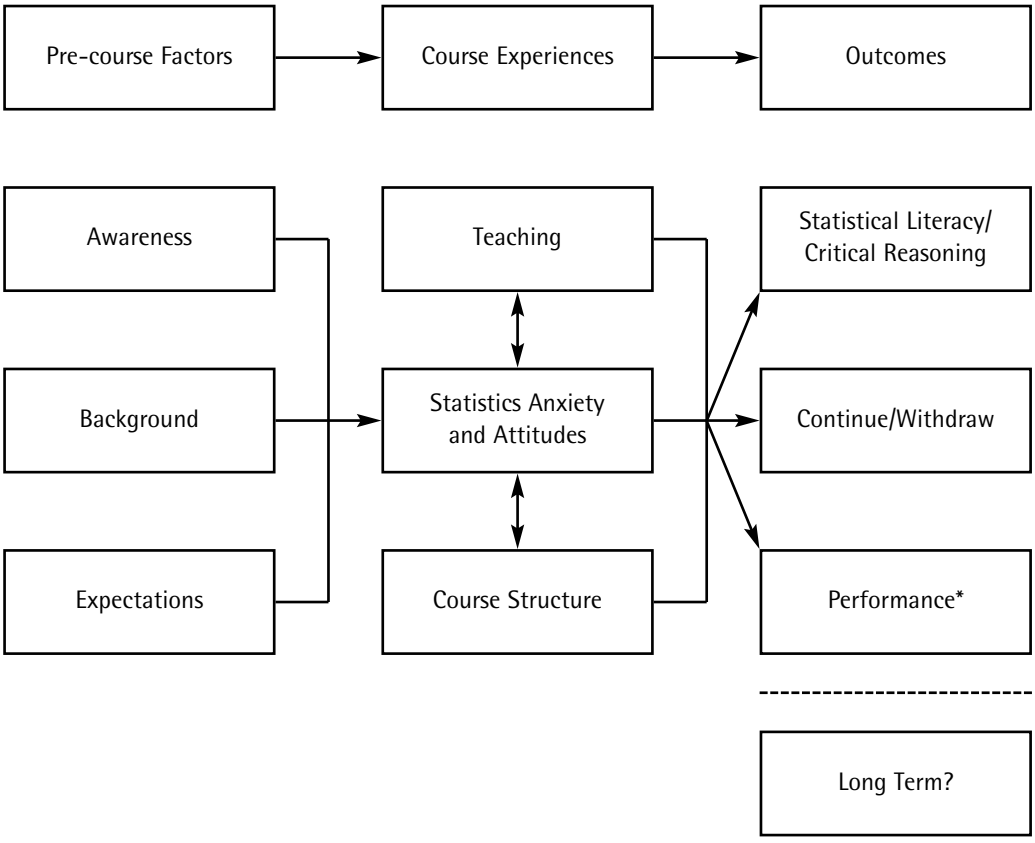
Figure 1: Change in perceptions of statistics across year.



a novel idea, but it strongly suggests that better understanding of even simply the theory behind statistics is something that all students – not only those pursuing scientific degrees in higher education – need to acquire when young.

Figure 2 represents the timeline and influences on learning statistics (Ruggeri, 2009). These were selected based on the findings from the overall study. The general concept is that the understanding students have about their course will impact their experiences in studying statistics. Their experiences, influenced heavily by the way the course is taught and structured, in turn determine their disposition and emotions toward the subject. The result of these collectively then is seen in how well students are able to acquire statistical understanding, apply related skills, and finish their course. As assessment is highly subjective and likely unable to capture long-term benefit, performance is not considered a critical aspect (Ruggeri, 2009). Furthermore, the long-term aspect has not been the focus of major work and is thus difficult to consider. However, a major omission from this model identified in the preceding results is understanding the nature of statistics. Given the arguments listed, this must come at some point for these students, if not many others.

Figure 2: Model for statistics education timeline.



The impact of overlooking

The decision to report the selected results stemmed from essentially post hoc examination of the research. As it was being carried out, the intent had been to find the most extensive explanations of statistics anxiety and negative attitudes. However, this was at the expense of merely looking for the most useful results. While such exclusion is not uncommon, it raises questions about the benefit of learning large amounts of statistical methods in place of more time spent on basics.

This perspective teaches two main lessons.

1. The need to produce the most useful analysis must overcome the urge to produce the most complex, impressive one.

Without appeasing to the notion of more mainstreaming in statistical reporting, academics need to encourage students not to focus on impressive methodology and techniques as much as producing an accurate report.

2. More time should be spent instructing students on how to find appropriate result instead of covering the most topics possible in a short time.

If the basic nature of statistics is truly having such a tremendous impact on students, then there is clearly a need to focus more on basics until they have acquired a stable foundation of the discipline. Without this, it is unlikely that they will be able to progress beyond what has been taught to them once out of their course.

Conclusion

Much about how students will experience the statistics aspect of their course can be determined by their level of understanding about statistics before they begin. Furthermore, this concept applies not only to students but to the general population, as they are constantly impacted by information mistakenly identified as statistical. For teachers of statistics, this should be treated as a crucial element when developing the structure of such courses.

Acknowledgements

Thanks to a bursary provided by the DTRP, the core of this paper was presented in their symposium at the 2010 BPS Annual Conference. Many of the thoughts included in this report came from suggestions and feedback from that symposium. Credit for the author's study goes to Queen's University Belfast.

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