A way of teaching statistics: An approach to flexible learning

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Introduction

Over the past few decades there has been a debate about the reform of statistics education. In particular, many educators are interested in finding a better answer to the question, 'How can students' learning be improved in statistics education?'. Although modern statistics has many visible applications as well as a high demand in employment, students are still moving away from learning statistics. Since the reason for this is not very clear, we must tell the students (and potential students) that statistics forms a strong basis or foundation for many fundamental and experimental studies apart from standing on its own as a discipline. Since most of the theories in statistics are based on mathematics, teaching statistics becomes more difficult than other subjects. Teachers need to find better ways to resolve these difficulties in teaching and answer the common question, 'Why do students need to learn theoretical statistics via mathematics if statistics is supposed to be rich with applications?'. It is, indeed, a very difficult question to answer, i.e. like making a journey in a cart (statistics) without a horse (mathematics).

What is statistics?

Statistics is a discipline or a branch of mathematics dealing with the collection, analysis, interpretation, and presentation of data from any random experiment. These data or observations fall into two categories called qualitative and quantitative. Each observation is considered as one of the values from a set of all possible values. Hence, this observation is considered as a value of a random variable. Due to this uncertainty of outcomes of an experiment, the concept of probability theory is required to understand the basics of statistics. Based on these views, many elementary statistics courses cover the topics; random experiments, data collection, summarizing data in tables and graphs, some important measures for location and dispersion, relative frequencies and introductory probability, some important discrete and continuous probability distributions, normal distribution, sampling theory, statistical inference, goodness of fit tests, and correlation and regression.

Before beginning to teach a topic from the syllabus we must tell the students 'what's the use of this topic in statistics and what sort of situations are there to apply this in a real world situation'. As mentioned before, the concepts in statistics are developed around 'randomness' or 'uncertainty'. Like in many parts of mathematics, in statistics our main aim is to find the best model for a particular pattern of observations. Here the word 'best' means with 'least uncertainty' or 'more confidently'. It is anticipated that no one can predict an outcome or result of an experiment with 100% confidence. Due to these reasons, statistics becomes an abstract subject, and hence, getting students motivated can be very challenging. However, properly motivated students will have, indeed, a 'deep learning ability' which is usually the 'learning with pleasure' that lasts forever. There are a number of possible ways to handle this situation. Some of them are given in the next section.

Effective teaching and flexible learning

Very often teaching and learning at the university level seems to be focused on students passing the prescribed assessments/examinations and gaining (at least) the minimum credentials for the required degree. It is clear that in such an environment, long-term objectives of teaching or learning are unattainable. This is particularly true for teaching statistics, where a vast majority of students who follow statistics as service courses have no intention to continue as majors.

Teaching is increasingly being recognized as a complex and multifaceted product of many variables. All signs point in the same direction - the culture of teaching and learning is changing. Although this evolution is faster in many subject areas, it would be difficult to deny the decreasing visibility (or trend) of teaching and learning in mathematical sciences, in particular, in statistics. This fact is evident in the drop of the number of students in statistics majors in many Australian universities over the past 10 to 15 years.

Effective teaching begins with proper planning. Courses must be planned; chapters and units as well as each class must be planned with carefully chosen material and examples. A complicated topic like hypothesis testing, for example, may begin with a problem from today's newspaper or from a recent article: suppose that the Government claims that the unemployment rate is 7%, while the opposition parties claim that the government is underestimating this figure to win the next election. Clearly, there is a dispute between these two groups. How can this dispute be solved using statistics? This is a good time to introduce the basic methods that can be used. Now the teacher should define the standard technical terms and procedures in a systematic fashion. An approach like this is more interesting to students than looking at traditional textbook technique (i.e. define the null and alternative hypotheses, etc., etc.). This is evident from the feedback I have received over the past 25 years of teaching mathematics and statistics across a diverse range of countries and cultures. Many topics in statistics can begin with a lively introduction as seen above, followed by slowly explaining the theory. This needs a fair amount of time for planning the teaching schedule. Hence planning stands as the core process of teaching. In each topic one must clearly define the objectives and lay out the most effective way of accomplishing those objectives together with good examples. Always make the assumption that students are in the classroom to learn. Use different strategies to encourage understanding of the relevance of the theoretical materials and classroom work to students' personal lives. Also, always include many examples and problems for practice in order to reinforce difficult concepts via real world situations.

Concluding remarks

Teaching is itself learning. It is true that teachers always learn more than their students: teachers need to prepare the subject matter well enough to suit the level of students and their learning ability. To learn more about students' learning capabilities, a constant interaction between students and the teacher is important. Look for signs from students of understanding the material. Usually their body language is a simple and sensible guide to judge the effectiveness of teaching. Another strategy that I use is daily feedback as a constant appraisal process and as an opportunity to respond to any unanswered questions. This is sometimes not possible in large classes. Teachers of large classes are well aware of the challenges that surround teaching several hundred

students at once. However, even in large classes, patient teachers can always understand the difficulties that students have by using the approaches mentioned above, or by finding their own ways to teach more effectively according to the situation.

For many teachers in statistics, the archetypal discussion class is not a viable option. In large classes, it is advisable to divide each class into small tutorial groups in order to teach problem solving strategies efficiently. Problem solving is a student-centred approach which provides students with the opportunity to participate, apply knowledge, and receive feedback on their comprehension of the concepts.

The final remark is related to the use of technology in statistics education. Although computers can solve problems efficiently, one should bear in mind that they will never totally replace teachers: the main reason for this is that the numbers or graphs produced by computers do not make any sense without proper explanations. There must be skilled people to interpret and draw conclusions based on computer outputs. This again reinforces for us the importance of statistics education. Computers have become highly integrated into all aspects of academic life and it is difficult to imagine higher education without them. Hence designing any course in statistics must include the use of knowledge of computers and technology to suit the current demand in the job market. Constant interaction with industrial, financial and other relevant institutions is necessary to create up-to-date and modern course design strategies which include the use of computer technology.

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