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Simple Notes in Teaching Medical Statistics in a Short First Year Course

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Short commentary

In this simple manuscript I describe some elements of my experience in teaching medical statistics in a first year course in Medicine, Dentistry or in general in a healthcare degree course. These are usually short introductory courses of around 20 hours aimed at students who have just arrived at the University, with very different mathematical and statistical knowledge. The idea is to provide students with robust basic elements, elements which can then be taken up and developed in subsequent years of the study courses.

It seems important to me to be able to share this experience of mine in order to compare it with colleagues who teach in other universities and in other countries. I think that it is very important in these years to discuss about teaching in University and in particular in teaching technical subjects in bio-medical courses. Many things have changed, and many are constantly changing, and we need to understand how to help students to approach new problems, with new tools available. It is very easy, for example, to use user friendly software, but often students do not know what they are really doing and what result they have achieved.

After a few years of research and teaching work in the theoretical Mathematics (I was dealing with problems of numerical stability of solutions of differential equations with delay), I found myself, almost by chance, collaborating with colleagues from the Department of Medicine, having had a teaching Medical Statistics: I therefore found myself trying to use my theoretical knowledge to address practical problems in the biomedical field. The challenge was very interesting and the teaching method also had to change as I was no longer in front of students in a mathematics class but in front of medical students or in general in the biomedical field. The students asked me: “but why do we still have to do mathematics?”; “what is the true and correct use of mathematics in Medicine?”; “why is Statistics quite impossible to understand?”; “I have a software result, but what does it mean?”; “what do you mean by statistical significant?”.

I still remember an example of collaboration with a medical colleague who was experimenting with a new diagnostic kit and who wanted to understand how to optimize the results: “as a doctor I would put the cut off value here, to say who is positive on the test and who is not but you, as a mathematician, where would you put it based on the data we have collected? What is your theoretical contribute to this problem?”.

It wasn’t easy to understand each other with my colleague: he used medical language, which I don’t understand, and I responded with mathematical language, which is obscure to him. It took time to learn to work together, each of us remaining competent in our own discipline but at the same time finding a new level in which to dialogue. As many already know, I managed to explain to my colleague the usefulness of the ROC curve in this case. This simple situation was important in our collaboration and it was possible to work together in other experiments.

An important first step therefore seems to me to be to present Statistics starting from simple practical examples, preferably those resulting from research work in which one is engaged. Even better if you have the opportunity, at least sometimes, to present the problem together in class, doctor and statistician, in order to show both the specificity of the individual discipline and the possible collaboration between different fields.

Another important point in my experience is not to present at first the formulas that define the tools of Statistics, formulas

that are often not understood or, even worse, only learned by heart, but to start from a practical situation or, better yet, from a particular example, to only then arrive at the formula and its correct use. The use of some platform is very useful for comparison with the class, especially when there are many students in the classroom (e.g. classes with around 200 children). For example, I use *wooclap*, asking questions, asking for opinions, proposing exercises: usually all the students present (but also those who are connected from home) respond in a very proactive manner, giving the opportunity to discuss together what was answered in the platform itself.

One interesting example to introduce statistics is to discuss about utility of average in getting informations: I invite the students to have a drink together with a group with an average age of 20 years: which group do we expect to find? The class usually accepts enthusiastically this invitation because they think to find a group with young people. But there is always some student who expresses some doubts: "there could also be adults and/or children (which is obviously not a negative thing). After some discussion, we come to understand that in a group with an average age of 20 there may not be any young people (grandparents with children, for instance)! This is an opportunity to remember how the average is defined, but above all to understand what information it provides us (which is particularly useful if the average has to give me bio-medical information). It is therefore an opportunity to introduce the concept of median, particularly if there are extreme data. Hence the possibility of talking about the boxplot graph and the information that this graph can provide on the distribution of the data and on any outliers.

My experience says that a method of this type, also defined as laboratory as the class is involved in various ways in the lessons, is usually engaging and helps students to think, before learning formulas by heart and I think that it is not difficult to understand similar topics, for a doctor, too.

A small note: after the pandemic, I get the impression that students are finding more and more difficult to learn new topics, going deeper into what they are learning. They are kids who learn many things instinctively, but if they don't immediately understand some passages, they are not able to stop to try to understand. This year, after noticing these difficulties and after seeing that everyone was taking a lot of notes following an enormous number of slides (I made an estimate of how many slides a student sees in an academic year, and it came out to be a terrible high number), I decided to make a "pit-stop" every now and then. I stop and I give the students exercises in class, and give them time to think about them alone and then in small groups. At the end, I ask those students who have not really managed to arrive at a solution to intervene and so we discuss together, highlighting the difficult passages. Students are usually very happy for this simple method, taking the time to stop and go in depth, individually and together, and it seems to me to have been very useful for a better understanding of statistics.

Another simple example, this time linked to an element of inferential statistics: how to introduce the concept and the formulas of the so called confidence interval. I do not start from theory, from formulas (which is not appreciated by an audience in the bio-medical field), and this without taking nothing away from the importance of the theoretical part of Mathematics and Statistics, but from how we usually, unconsciously, use confidence intervals in our everyday lives. When we give a friend an appointment, we don't just say "I will arrive at 7 pm" but, "I will arrive around 7 pm". In fact, a precise estimate is not informative as it does not indicate the uncertainty of the estimate itself. Without knowing it, we make the appointment with a confidence interval: in fact, we say: "I will most likely arrive between 7 and 7.15 pm", giving the interval estimate, but also confidence in this estimate. At this point it is simpler to describe some steps that lead to the construction of a confidence interval and to explain some formulas.

I use similar examples to introduce other Statistical elements, but this is not the place to present them. Here are, as promised, only some notes on my experience teaching medical Statistics in the first year of a university course in Medicine, Dentistry or a Healthcare degree. These are just some titles that must then be developed during the course itself.

I see that students carefully follow lessons presented in this way and can lay the foundations for subsequent courses in which some more advanced and refined techniques will then be developed. These are introductory lessons that do not require great knowledge of Mathematics and therefore can be understood by students even from very different schools. The fact of being able to show Mathematics and Statistics as useful tools for bio-medical disciplines helps to direct students towards future collaborative work with colleagues from different disciplines.