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Creative Thinking Through Actuarial Projects

By Stefanos Orfanos

This article—and the short presentation I gave at the 2019 Actuarial Teaching Conference (ATC)—arose from teaching a two-course sequence in loss models last year. I would like to express my gratitude to the ATC committee for the opportunity to present, to colleagues for their interest in what I had to say and to Professor Colin Ramsay for the invitation to contribute to *Expanding Horizons*.

There is a sense of individualism in actuarial science that is quite distinct from other subjects. A common belief is that students can major in any one of many disciplines and end up becoming actuaries, so there is considerable freedom about the choice of curriculum. Even when they major in actuarial science, the understanding is that they will eventually have to study on their own. And finally, the actuarial courses they do take often have a very narrow focus: to help them pass the corresponding exams.

A side effect is a paucity of discussion on the application of pedagogical theories to actuarial science and, in particular, a lack of a creative pedagogy for actuarial science.

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But what is creative pedagogy? It can be defined as the educational approach that seeks to inspire and grow students' creative faculties by means of suitable learning activities and experiences. And what is creativity? This is perhaps best illustrated by means of well-known examples from math or physics, such as Archimedes' idea to measure the volume of the king's crown by submerging it in water, young Gauss' ingenious summation trick to the question $1 + 2 + \ldots + 100 = ?$, or even the standard way of showing that the Gaussian density actually integrates to 1. Creativity is thus the result of an idiosyncratically deep understanding.

Creativity has been celebrated through the ages. One may argue that is because it is so rare or so difficult to cultivate, but a closer look reveals that is not necessarily the case. In fact, some societies saw a tremendous blossoming of creativity at certain times, while at other times they were stagnant. It is rather the outsized impact that creativity can have on human civilization and progress that is the key. Looking forward to the coming era of automation, it seems plausible that creativity will be the deciding factor between being valuable and relevant in the workplace or being made redundant.

The first goal then is to develop a separate concept of creativity, one that aligns better with the practice of actuarial science. Whereas math creativity is traditionally associated with abstraction, clever proofs and calculation schemes, actuarial creativity will have more to do with reliable answers to open-ended or ill-defined real-life business problems that require approximations, modeling and additional assumptions to strictly make sense.

The second goal is how to teach creativity. The emphasis on speed and accuracy when applying a given method, while common in most courses that are meant to prepare students to pass actuarial exams, does not seem appropriate for promoting creative thinking and ought to be supplemented with activities where the focus is on the student's ability to deal constructively with ambiguity. If it is a class project, it should lead the student to carefully examine various sources of information and model different scenarios before eventually coming up with a rational and defensible answer (or range of answers).

There is no consensus on how to select or design suitable projects to cultivate creativity, but the following list of first principles is a good starting point:

- They should go beyond the theory learned in class.
- They should introduce ambiguity in terms of assumptions or methods.
- They should mimic real-life business problems, with realistic constraints on time and data.

One particular application of this approach is in the teaching of classes on loss modeling, ratemaking and loss reserving. There, one may start with the modeling of made-up data (perhaps mixtures or compound distributions), then of real loss data, then of big loss data. Through these activities, students will discover

that the theory taught in class should be approached critically rather than used in a plug 'n chug fashion. They will also be confronted with imperfect data and the limits of the statistical tools they are using (if in Excel), forcing them to seek creative ways to overcome these challenges.

Real data are almost always more complicated than the theory would permit. For example, flood data can consist of normal events and catastrophic events, but the data may not allow disaggregation without a good amount of additional research. Further, there are spatial correlations, in the sense that when a hurricane hits Louisiana, it's very likely to affect Mississippi or Arkansas or Texas as well. Students can use what they have been taught in class but should also be encouraged to go beyond these facts and investigate what theory and tools they really need to deal with the problem at hand, or what reasonable assumptions they can make that allow them to work out an answer.

Another dimension is the line of business: there are available loss data for personal and commercial auto, workers compensation, medical malpractice, product liability, flood insurance, marine insurance and so on, and each exhibits its own unique behavior in terms of loss development. Digging into the differences and the reasons for, say, the change in the speed of finalization of claims promotes a deeper appreciation of the subject and develops actuarial judgment. The same applies to credibility theory. Rather than specifying the method, why not try to test all of them and compare the results to common sense or explain the discrepancies?

Students may resist or resent these projects, since there is safety in a prescribed method and ambiguity often causes anxiety. But educators should refrain from giving a template of what the solution should look like. Instead, they may:

- Provide guidance if students are confused.
- Encourage experimentation and resourcefulness.
- Reward continuous improvement.
- Require clearly stated assumptions and sanity checks.

A last aspect concerns how to communicate creativity properly. Many students make the assumption that math and science classes are off limits for the grammar police, and sometimes they let go completely. It is our responsibility to reinforce that good writing is an indispensable skill that should be practiced at all times. Beyond spelling, grammar and syntax, consideration should be given to the editing of the text until it conveys the intended message with brevity and impact. Useful conventions of professional writing—such as a structure consisting of a summary, analysis and recommendations—should be insisted upon. Finally, the choice of graphs and visualizations should call attention to the important features of the data. ■

Stefanos Orfanos, FSA, CERA, is a clinical assistant professor and the director of the undergraduate actuarial science program at Georgia State University. He can be reached at *sorfanos@gsu.edu*.