

Develop Students' Key Actuarial Capabilities in College

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For over 150 years, the actuarial profession has contributed to the growth of financial markets especially in the areas of insurance and investment. The Bureau of Labor Statistics, in its Occupational Outlook Handbook, forecasts a 26 percent increase in the number of actuarial positions by 2022. [The CareerCast.com](http://TheCareerCast.com) website listed actuary as one of the five best jobs of 2015.

Actuarial Science is an important field of Applied Mathematics. It requires Mathematical and Statistical skills to study and analyze uncertain events in the insurance and other financial fields. Based on the increasing demand for actuaries and the promising job outlook, more and more universities and colleges have begun offering Actuarial Science programs. In the SOA 2016 University & College with Actuarial Science Program (UCAP) list, there are 150 universities & colleges in the US and 16 in Canada that offer Actuarial Science programs, among which 17 in US and 8 in Canada are distinguished as Centers of Actuarial Excellence (CAE). What are our expectations from our actuarial graduates? What actuarial capabilities should they have upon graduation?

1. Introduction—what are actuarial capabilities?

What are actuarial capabilities? Different actuaries will give different answers for the set of capabilities that characterize a good actuary. A lot of terms commonly used are thoughtfulness, carefulness, quantitative skills, innovative thinking, problem solving, creativity, good communication, leadership, etc. Can actuarial students develop such actuarial capabilities in our current actuarial college curriculum?

From Shepherd [1] and [2], capabilities are not “acquired” in a single course. Capability development is an on-going process. A super-complex world demands effective learning based on inquiry, discovery, articulation and communication rather than passively based on receiving, imitating and reproducing. Educational

research consistently shows that the development of capabilities is more effective when development opportunities are integrated with core knowledge learning, and results in enhanced understanding of knowledge content when integrated with it. Passing actuarial exams is not sufficient to be a successful actuarial candidate. Self-learning abilities, problem solving skills and business skills including collaboration, and communication are the actuarial capabilities one should develop in college. These skills are closely connected to each other.

2. Improve students self-learning abilities

Actuaries are lifelong learners. I strongly agree with McGinnis and Powills [3] that: “Swift changes in the actuarial professional require continuous learning and development of new professional skills. All actuaries have a professional responsibility to pursue lifelong learning and stay up –to-date.” Self-directed learning skills involve the ability to manage learning tasks without having them directed by others. They are skills necessary for effective lifelong learning.

Our traditional teaching approach in the classroom is teacher centered and teacher controlled. Students are passive learners. College students generally pass several exams upon graduation, thereby qualifying for attractive employment opportunities. There is no doubt that supporting students to pass the preliminary actuarial exams is at the core of what we do and students become competitive candidates in the job markets upon graduation. But we cannot ignore the importance of cultivating self-learning skills. At the same time we also need to make sure that our students have not only the required subject knowledge to pass an exam, but also the broader learning skills needed to make a successful transition into future actuarial education and the workplace. Actuarial students continue to learn throughout their careers and take great pride in passing the strenuous exams their profession requires for certification while working. After achieving actuarial credentials, all members are subject to complete the CPD (Continuing Professional Development) requirements. There are several study manuals available for future exam preparation and Actuarial organizations such as SOA (Society of Actuaries) and CAS (Casualty Actuarial Society) provide a variety of educational opportunities (publications, webcasts, seminars, meetings, e-learning courses and section newsletter articles) to help members meet their formal and informal learning needs and requirements. Most insurance companies allow their employees to take regular time off to study for actuarial exams or CPD. However, how do you decide which educational opportunities will meet your formal and informal learning needs and requirements? No one tells you exactly which paper to read, which meeting to attend or which webcast to join. After

leaving college, students have to direct all study tasks by themselves and manage the balance between work and study.

It is an important responsibility of teachers to train students' independent learning ability in the teaching process, so that students can master the actuarial knowledge independently, and apply actuarial and scientific knowledge to solve practical problems. We can provide more opportunities for students to develop competence and autonomy which also developing their mathematical thinking and reasoning. The expectation is that students will become self-directed learners as they mature and gain content knowledge.

To develop students' self-learning abilities, appropriate teaching method must be employed. It is not enough to teach students how to apply the rules we have developed to attack the problems. Understanding why and how we found the ways to solve those problems is even more important for them. They will encounter problems on the actuarial exams which they have never seen before and work on projects that lack detailed instructions. Besides needing to recall techniques and skills they have learned, their college training must prepare them to think and develop their own ways to solve problems. To achieve this goal, we should explain the logic behind the steps of the solutions and encourage the students to find their own path to a solution. By guiding students to find the connections and differences among these problems, at times reminding them of the tricks for some problems, students will gain confidence and improve their skills. We also need to guide students in the use of outside resources. In many cases, the work tasked to do is new both to the student and the company he or she works for. This requires a demand of investing a significant amount of time in learning new things. A successful actuary is not afraid of facing new problems and knows how to formulate good questions and do research on the related subjects accordingly. Finding a feasible solution through the research requires the actuary to be proficient in utilizing the available resources and make good judgments from time to time. It is fairly common that the resources available (data, actuarial software, people and etc.) are not ideal, but the need for results is often immediate, so one has to be creative and know where to make the compromises to come up with imperfect solutions to meet the needs of the business.

The success of independent and self-directed learning in the classroom is largely dependent on the teacher. Teachers not only have a strong knowledge and understanding of their subject, but also have a real passion for it. Teachers are expected to spend sufficient time with each individual student to identify their learning needs and to support their broader skills development. In college, what

and how students learn depends to a very large extent on how they think they will be assessed. From my own experience, when students are asked to write about, debate, explain research and apply the core concepts and principles of the discipline they are studying, they achieve deeper understanding of what they are learning. Because learning objectives and testing methods are not consistent, this often leads to ill-directed surface learning. Except for the SOA (Society of Actuaries) MLC (Models for Life Contingencies) exam, other preliminary exams are all multiple choice problems. Instead of trying to understand the reasoning behind the problems, students try to remember familiar problems and solve similar problems by memorizing formulae. The best way to change our students' behavior is to change the nature of assessment in our teaching. Conventional examinations are not well suited to assessing many of the capabilities our students need to be developing.

One major benefit of open-ended questions is to push the students to focus on the process of thinking and finding a solution instead of focusing on the results. We can design appropriate assessment methods for capability development (e.g. projects, research, authentic tasks, written reports, presentations, etc.) that are individual and collaborative. Instead of asking for just numerical results, we can ask students to translate their mathematics into words. In the written tasks we developed, the students were frequently asked to explain their solutions and strategies, and the students were invited to find several solution strategies to a problem. The process of explaining leads to better understanding in the learning process and at the same time develops students' good learning habits. We would rather see an imperfect answer through the student's good research than a perfect answer the student found in a wrong way. From a teacher's perspective, such questions may appear unattractive because they are time consuming and take longer to read and mark. However the students' learning outcomes are better. It is important that teachers provide timely and constructive feedback, not only looking at the resulting information but also commenting on the research process of the student. In these instructional activities, students gradually develop their own ideas, apply the mathematics in realistic situations and draw their own conclusions; therefore their self-directed learning abilities are cultivated. With confidence in their own abilities to do their own research and learning, the students can then be given more autonomy over what they are researching and what sources are used to do the research.

3. Problem based teaching approach to develop problem solving skills

Actuarial work involves lots of math, but actuaries must also be up-to-date on business issues and trends, law, social science and economics. Actuaries have a well-rounded business approach to problem solving. One of our learning objectives is to be able to solve insurance and financial problems related to risk assessment and perform related calculations by applying standard actuarial methods. It is important that teachers in problem-based environments develop a broader range of pedagogical skills. Problem based learning fosters the ability to identify the information needed for particular problems, where and how to find the information, how to organize the information in a meaningful conceptual framework, and how to communicate to others. Teachers pursuing problem-based instruction must not only supply actuarial knowledge to their students, but also know how to engage students in the process of problem solving and applying knowledge to novel situations. Opportunities for students to develop these skills must be embedded in the core actuarial curriculum. In problem based learning, the problems are the curriculum. The challenge for curriculum development is to find a set of problems at the appropriate level for target students that require acquisition of all the fundamental knowledge and skills. The actuarial curriculum should emphasize the interplay between the abstract mathematical theory and the application in professional practice. Though preparing students for the actuarial professional exam is the most important component in most actuarial programs, we should find the right balance among three important curricular components: a developmentally appropriate and rigorous treatment of the underlying theory, applications to idealized situations such as those on actuarial exams, and messier applications that connect the theory to actual data and models that are encountered in practice. We believe that students will have a more valuable actuarial educational experience if their actuarial courses are based around a careful development of the structure of the underlying theoretical ideas, supplemented and strengthened by appropriate practice exercise. For example, while preparing students for the SOA Exam MLC (Models for Life Contingencies), the mathematical treatment is nicely complemented by examples that students can do using spreadsheet software and by comments that connect practical issues facing insurers to the theory discussed in the text.

For freshmen and sophomores, we can give students a good business orientation from the start while they are studying for the early examinations. It is important to have an early orientation course to help new students see how and where the technical subjects that they are studying, or are going to study, are applied in practice. These introductory courses give students important insights into economics, an introduction to the business world, corporate and financial

structures, as well as some preparation for later finance courses. In addition, this bridges the gap between actuarial science and practice.

In upper level courses, students should have exposure to advanced practical open problems. We should collect and design examples to show how analytical, mathematical and statistical methods can be used to make commercial decisions about the future and how actuarial models work within the business context. When we read papers, go conferences, or participate in live webcasts, we sometimes find a fascinating problem that will engage our students. We need to record it and study it until we can articulate what mathematics, both content and processes, it involves, and then file it away for when we are teaching those actuarial ideas. Some case studies in FAP (Fundamental Actuarial Practice) e-learning course are good choices. Instructors can modify the context and data based on their needs and adjust the difficulty level so that students can understand. Students get to see the mathematics and business topics being used in an actuarial context. Most exam related problems are from practice with single answers, while effective learning is based on discovery. We need to ask more open-ended questions in class to encourage higher-order thinking. Open questions have multiple answers, and permit creativity, self-expression, and richness of detail while unanticipated findings can be discovered. For some difficult content, we can design group project. Through their work on the projects, students discover that the math they are learning is useful. The projects focus on applications related to the students' courses of study and future prospects. The projects often don't have a unique solution but rather have several preferred solutions similar to the types of problems professional face in the real world. Students are expected to meet as a team outside of class to work on the projects. Teachers help students to focus on solving problems within a real-life context, encouraging them to consider the situation in which the problem exists when trying to find solution. For advanced students, the instructor can let groups solve the problems without hints, but the instructor may provide questions to promote student thinking. Students better understand the logic and reasoning behind these techniques, with particular emphasis on the insurance market, through practical real world problems. Upon graduation, students think critically and are able to analyze to solve complex real world problems on their own.

Actuarial science includes elements of applied mathematics and statistics and the large amount of complex calculations are common in an actuary's daily work. Many actuaries spend their time using computers to analyze volumes of data and building mathematical model within different analytic platforms ranging from simple Microsoft spread sheet to enterprise level solution like PolySystems. The

penetration of information technology in our daily life and the business world has enabled us to collect ever more data from businesses and consumers. The growth in big data and efficiency-seeking drive the actuaries to learn new technologies to be proficient in dealing with the digital world.

Even an actuarial intern is expected to perform complex calculations in spread sheets without much on-site training. Knowledge in mathematics and business provides the foundation for the solution to a problem. However, students need to utilize some software to implement the solution which often includes analyzing data and constructing models. Because of the importance of programming skills, in our curriculum we encourage students to apply VBA programming to enhance their problem solving abilities. When formulating a customized solution for a complex problem, the actuary often finds it impossible to achieve the goal by simply adjusting some parameter values in an existing model. New models must be created, and if the involved data is large and efficiency is required, programing is normally unavoidable.

4. Business skills-Collaboration, Communication and Networking

Actuarial Science is primarily a tool for making strong business decisions. Actuaries apply analytical and business skills to solve a growing variety of financial and social problems. Collaboration, communication and networking are important business skills for actuaries. Inducing business skills or adding some business courses in our actuarial training program would ensure that the subjects are taught with an orientation towards practical applications in a business context, and help the future actuary collaborate and communicate well with their managers, their colleagues in other departments and their clients.

Collaboration is one of the most valuable actuarial capabilities. “Collaboration” means being able to be part of a productive and efficient team that gets the job done. Collaboration involves close cooperation, clear shared goals, and a structured system of discussion and action to achieve them. Collaboration is important in our teaching approach and in the real world our graduates will be expected to exhibit this skill. Through working on group projects, students learn from problem-solve cooperatively, and learn to appreciate the true value of teamwork. When the students are given problems they are not familiar with, we want them to collaborate. Students work in groups to identify what needs to be learned to solve the problem. They then learn to function as a team, negotiation and mediation skills, to distribute cognitive responsibilities amongst members, and to externalize thinking through explaining ideas to peers. From collaboration,

the students have an opportunity to experience themselves and their peers as active participants in creating mathematical insight. Every student brings a personal contribution at his or her level. Sound communication skills are developed during the process. These elements of our design study were suitable for meeting the students need for competence, autonomy and relatedness. Collaborative learning shifts the responsibility for learning to the student, in the role of “researcher” and self-directed learner. Students become better self-directed learners and improve problem solving skills from collaboration with others. In addition, the instructor needs to develop the project and design the project evaluation carefully to encourage active participation of all team members. A good evaluation system should be able to (roughly) identify individual team member’s contribution and the major contributor should naturally be awarded with higher credit within the team.

The Actuarial profession is globalizing and expanding to emerging countries. SOA has over 26,000 members spread across 78 countries. Most of SOA members who are not in the US and Canada are in Asia, Hong Kong and mainland China. Asia is clearly a promising area for finance and insurance markets with steady growth expected in the coming years. Research shows that working internationally makes people more flexible and creative and increases their ability to think strategically. It’s also increasingly important that teams with members located in different parts of the world learn to work together effectively. Actuarial faculty members with international backgrounds are encouraged to look for partnership opportunities with actuarial organization and university actuarial programs from their own countries so that our students have a wide range of opportunities to better understand how actuarial principals are applied in other countries.

Many international students enroll in actuarial program at universities in the United States and Canada. We expect American students all over campus will come into daily contact with international students in classes, dormitories, and social events to share and exchange knowledge and insights about their respective countries. We encourage American students to collaborate with international students in group projects and students learn the skill of “collaboration internationally” while in college. Collaborations with our foreign students are essential to the success of our global activities. They are also often the most rewarding, educational, and enjoyable experience in college.

In addition to their mathematical analysis and problem-solving abilities, actuaries need to have excellent oral and written communication skills as well as a basic

understanding of economics, finance and corporate structure and decision making. Actuarial students are expected to be able to communicate quantitative analyses clearly to various audiences, both in writing and orally. Courses emphasizing speaking and writing should be included in the actuarial program. A course in technical writing is also useful and highly recommended.

An ideal actuary has mastery of technical and mathematical material, can apply it in its proper context, and can communicate it to an appropriate audience. To collaborate well with others, one should learn how to be a good listener and a good negotiator. Good listening skills can provide you with a deeper level of understanding about someone's situation, and helps to know what words are best to use or which words to avoid. A good negotiator listens well, shows patience and flexibility, points out shared ideas and areas of group agreement, and thinks under pressure. Forming an Actuarial Club can be a good vehicle to provide students experience in giving presentations on different actuarial topics. Students share experiences with working projects and internship, and discuss study strategies.

Networking provides the most productive, most proficient and most enduring tactic for building relationships. To succeed one must continually connect with new people, cultivate emerging relationships, and leverage your network. Business networking is a valuable way to expand knowledge, learn from the success of others, and tell others about your business. Actuarial programs benefit tremendously with the relationship between local insurance companies/actuarial consulting firms and professional organizations. Actuarial alumni and local actuaries provide guidance in curriculum development and ongoing advice for our program and help undergraduates to find internships and positions. Local actuaries' campus visits and company presentations are the best approaches for students to learn updated information about the industry and hiring opportunities. Internships provide students the opportunity to develop career interests and skills in professional settings. We advise students to participate in many networking and development events to expose them to various actuarial areas. We encourage our students, especially freshmen or sophomores, to use networking tool such as "LinkedIn" and "Twitter" to build networking connections.

Some international actuarial students who studied in North America will return to their home country or elsewhere to pursue an actuarial career. We always like to see our international students starting to network with the actuaries in their home countries early. For both international and US students, networking with professionals from other parts of the world can broaden their understanding of the global marketplace and open new career opportunities. An appreciation of how

people in other countries think and act can be extremely helpful for actuaries, who often need to make assumptions regarding the future in global context. It allows you to view your own country through the eyes of an outsider and enhances your own insight.

5. Conclusion

A successful Actuarial Science Program focuses on developing the key capabilities of an actuary which include self-learning abilities, problem-solving skills and business skills such as collaboration, communication and networking. It needs talented and committed faculty members, strong support from the university and good networking with local actuarial employers to build and maintain high quality.

Reference:

[1] Shepherd, J, "*A Blueprint for an actuarial education*", International Congress of Actuaries 2010, South Africa

[2] Shepherd, J, "*Beyond Knowledge: How to develop actuarial capabilities*", Division of Economics and Financial Studies

[3] Mcginnis, J and Powills, J "We are lifelong learners", The Actuary Magazine, April/May 2015, Volume 12, Issue 2