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Editor's Report

I am pleased to bring to you the 2022/2023 Issue of *Journal of Risk Education (JRE)*.

We had a record number of papers submitted for consideration this year. My role in administration at East Carolina University has interfered with timely processing and review of papers. To all who have submitted, I do want to express my sincere apologies.

I am in search of three additional Associate Editors. If you are interested, please e-mail me at editor@jofriskeducation.org, and, please put "Associate Editor" in the subject line of your email. Doctoral students are most welcome to apply. Thanks in advance.

Please continue to send us your papers for consideration. If you have questions, don't hesitate to ask them.

Sincerely,

Brenda Wells, Ph.D., CPCU, AAI, CRIS, CICS

Editor
Robert F. Bird Distinguished Professor of Risk and Insurance
East Carolina University

Call for Papers

The *Journal of Risk Education (JRE)* requests submissions of articles and other materials for its 2024 issue.

Submissions should be formatted as follows for ease of publication:

1. Please single space all text, and indent the first line of each paragraph.

2. Use footnotes (no endnotes).

3. Do not include headers, footers or page numbers.

4. Use an 11 point font for all text, and please use font "Californian FB." Use **only** that font throughout the paper. Please don't mix different fonts together!

5. Include at the top of your paper the title in all bold print. Do NOT put author names in the file or in the file name. Capitalize the first letter of each word in the title.

6. Put all major section headings in all capital letters and bold print, centered in the middle of the page. Subheadings should be in bold print, aligned with the left margin of the page, and only the first letter of each word should be capitalized. Do not enumerate sections or subsections.

7. Do NOT use MS Word's section headings--headings and subheadings should be in plain text only.

8. Position all figures and tables exactly where they should appear in the text, rather than attaching them at the end of the document. This journal does not have a professional graphic designer to make your tables fit; it is your responsibility to put tables, exhibits, etc **exactly** where you want them.

9. Title your bibliography section in all capital letters and in bold print, as REFERENCES.

10. Format all references to have a hanging indent, and single spaced. Leave one blank line space between each reference. Make certain references are alphabetized correctly. Do not number references.

To submit an article for consideration, please create an account on our website at www.jofriskeducation.org and follow our electronic submission process. All papers must be submitted using the website. We are unable to accept e-mail submissions.

For questions and more information, please contact:

Dr. Brenda Wells, CPCU, AAI, CRIS, CICS, Editor

East Carolina University – editor@jofriskeducation.org

AI in Actuarial Education and Practice

Stefanos Orfanos
Georgia State University

In a future where risks must be tamed,
Actuarial education, acclaimed.
With knowledge profound,
And ChatGPT around,
Actuaries excel, unashamed!

—by ChatGPT

ABSTRACT

We study the impact of AI on actuarial education and practice, and make the case that the lessons learned in the actuarial field can be valuable for other risk disciplines. We begin with a discussion of Large Language Models (LLMs) and ChatGPT, highlighting their neural network structure and training procedures. We then examine the potential uses of ChatGPT in academic and professional settings, and identify ways it may influence the actuarial education and the future development of actuarial credentialing in the United States. More specifically, we explore how LLMs can be utilized as cheat codes, tutors, learning partners, teaching tools, virtual graders, and assistants. We also touch upon the implications of LLMs for actuarial practice, including the role of technology in shaping the profession and its ethical dimensions.

INTRODUCTION

Artificial Intelligence (AI) permeates our digital experiences, which nowadays comprise a large part of our existence. Increasingly our access to information, our work, the goods and services we buy, and our interpersonal relations and social life take place online, and all these are influenced or moderated by AI in ways we don't always realize. Consider that:

- AI algorithms analyze our online behavior, preferences, and interactions to provide personalized recommendations for products, content, and social connections.
- AI-powered systems are used to flag spam email and apply parental controls to filter out inappropriate or harmful material.
- Virtual assistants, such as chatbots, voice assistants, and customer service agents, enable automated interactions, provide support, answer queries, and facilitate online transactions.
- Natural Language Processing (NLP), a subfield of AI, allows devices such as Alexa to understand and generate human language. Other applications include real-time automatic captions, and music identification.
- AI algorithms are employed to detect and prevent fraudulent activities, such as identity theft or unauthorized payments.
- AI-driven web search generates personalized search results, enhancing our ability to find information online.
- AI is also used to automate repetitive tasks, optimize workflows, and improve efficiency in various industries. It assists with data analysis, decision-making, and process automation, allowing us to focus on higher-value work.

In this article, we examine the impact that AI and, in particular, ChatGPT and related chatbot technologies, can have on actuarial education and practice through the next several years. Although the actuarial function represents a narrow slice of the insurance and financial services industry, we argue that the lessons drawn will be of interest to academics and practitioners in many other risk disciplines. Moreover, we explore ideas for productive uses of such technologies in the academic and professional spheres based on our understanding of and experience with ChatGPT over the last few months.

A primer on LLMs and ChatGPT

Large Language Models (LLMs) are a class of machine learning algorithms at the forefront of AI. While a complete specification of a system such as ChatGPT is beyond the scope of this article, we believe a high-level explanation of how the technology works can increase interest in its use and dispel common misconceptions.

LLMs can be thought of as advanced AI systems designed to communicate in one or multiple human or computer languages. Deep down, they consist of configurations of neural networks that feed into each other. A basic artificial neural network is a collection of nodes that can receive input, store intermediate values, and produce an output. The nodes are connected with one another, and their connections govern how the input is modified at each layer of the network. Unlike the human brain, which relies on biochemical processes for memory and thought, artificial neural networks operate using algebra: input is turned into numerical arrays, and the strength of connections between nodes is represented by scalar weights that are applied successively and cumulatively to produce the output.

Initially, the connections in the network are assigned arbitrary weights, resulting in output that will most likely not match the expected response for a given input. In the case of supervised learning, the network is trained to improve its performance by minimizing the discrepancy between the network's output and what the response should be. The latter is provided by humans in the training data, with the goal of effecting incremental corrections to the strengths of the connections between nodes. Through this iterative optimization process, a sufficiently deep yet parsimonious neural network can almost always converge to getting accurate outputs for the training inputs and even for inputs it hasn't encountered during training.

A transformer is a more complex version of this basic model that can take as input human text and produce computer-generated text as output. It consists of an encoder network that creates numeric internal representations of the input, and a decoder network that generates the output based on these representations. Before being fed into the encoder, each word in the input is embedded into a semantic vector space. This embedding ensures that vectors representing words with similar meanings are adjacent. For example, the vectors for "risk" and "uncertainty" would be close to one another. The encoder considers not only the semantic proximity but also the position of each word in the input string as well as the syntactic relationship between words, by correlating each word with every other word. This mechanism allows the encoder to capture and store the contextual information surrounding the words in the input. The decoder, in turn, auto-regresses the output from statistical patterns by attending to words generated earlier and the perceived meaning of the input.

A Generative Pre-trained Transformer (GPT) is a specific type of LLM architecture introduced by Open AI. Generative refers to the model's ability to come up with language that is not found verbatim in its training data. Pre-trained refers to the fact that the model has already been exposed to an extremely large corpus made out of scraped internet text, Wikipedia, Stack Exchange, Github, and book collections, but it is not being instructed as to the veracity of the text that it is generating. Improvement of the model's accuracy can take place during fine-tuning, when it is instructed about what responses are deemed appropriate in a specific area and how a human

would rank them from best to worst, which helps the model recalibrate the weights in all internal connections between its nodes. Although a LLM can handle a variety of downstream tasks as-is, fine-tuning using human feedback can still enhance the sensible- ness, sensitivity, and safety of its output.

ChatGPT is perhaps the best known example of LLM. Launched in late 2022 and, unlike other LLMs, freely available to the public, it had reached one hundred million users by January 2023. In addition to an intuitive user interface, it displays superb conversational skills due to its careful fine-tuning that involves supervised learning as well as reinforcement learning from human feedback. ChatGPT also remembers the prior prompts within a conversation, which allows it to cross-reference and refine its subsequent answers.

Its remarkable performance across various language-related tasks has led to a wide range of use cases in healthcare, law, finance, and computer science, including for machine translation, sentiment analysis, document summarization, code generation, etc, albeit with limitations that will be discussed in the next section. It is important to note that there are many AI-powered chatbot models with their own strengths and weaknesses, some of which can accept or generate multi-modal data instead of just text, but ChatGPT remains the most popular choice, and so we have decided to concentrate on it and its application to actuarial education and practice.

Additional features and limitations

Research in the area of LLMs and other intelligent agents is ongoing and new models with expanded capabilities are announced every few weeks. Each of the latest models has many billions of tunable parameters and is trained on up to a trillion words, while the context window has reached up to one hundred thousand words, giving them huge potential for better text or data generation.

Some models, like DALL-E, GPT-4, midjourney, LLaVA, D-iD, and CLIP can understand or generate images and other media types, while some systems, such as Github CoPilot and Azure AI Studio are already (or can be) specialized to assist with particular downstream tasks. AI plugins allow LLMs like ChatGPT to interface with linked documents, to read extensive data files, or to outsource some tasks to computational engines such as Wolfram Alpha, resulting in much improved results.

Regarding model limitations, perhaps the most spectacular is hallucination (also called bullshitting by some experts): all known LLMs conjure up specific references to sources of information or facts and events that from the algorithm's perspective are statistically plausible although in reality they simply do not exist. Very recently, ChatGPT came up with a fabricated scandal about a prominent law professor, and got another attorney in hot water for making up fake judicial precedents to build a legal case against a defendant. In the realm of mathematics, the model claims with absolute certainty that $-e < -3$, although it also finds that $-\pi < -3$. In logical riddles too it fails often and spectacularly: for instance, it asserts that the sister of Sally's aunt's mom would be Sally's mother, or Sally herself if Sally's aunt is her mother's sister. A new training procedure called process supervision, which verifies not just the final output but also intermediate steps, is expected to reduce these instances of errors.

Another constraint is the cut-off date of its training data. For ChatGPT, this is September 2021. Consequently, the model doesn't recognize the term "Russian Special Military Operation" as the war in Ukraine and instead conflates it with the Spetsnaz. Helpfully, in the case of the Silicon Valley Bank, the model admits the data limitation and refers the user to the bank's financial reports for the latest information about its capitalization. Still, it rarely asks clarifying questions, unless it is explicitly instructed to do so or the prompt is missing crucial information. As a result, and for badly written prompts, it could miss the mark completely.

Scientifically oriented users will lament the non-reproducibility of ChatGPT's output for the same in- put. What this means is that responses will in principle vary in their phrasing and, sometimes, the essence, given the stochastic nature of the model that generates them. Finally, the complexity of these AI algorithms doesn't afford us a true understanding of their inner workings, while at the same time requiring massive resources to be built and trained. As LLMs get better at not giving obviously wrong answers, humans may have to rely more and more on such models owned by a small number of corporations, without being able to establish for themselves the ontological status of these algorithms, their relationship to truth, and the epistemological foundations upon which their results are based.

Literature review

There is already a vast literature on AI and its impact on various industries including higher education; a small sample is Huang, J., Saleh, S., & Liu, Y. (2021), Kuhail, M., Alturki, N., Alramlawi, S., & Alhejori, K. (2023), and Lee, D., & Yeo, S. (2022). We also should mention the earlier studies of chatbots by Adamopoulou, E., & Moussiades, L. (2020) and Okonko, C., & Ade-Ibijola, A. (2021) as well as the more recent investigations following ChatGPT's launch, by Adiguzel, T., Kaya, M., & Cansu, F. (2023), Ali, H., & Aysan, A. (2023), Alser, M., & Waisberg, E. (2023), D'Agostino, S. (2023), Haleem, A., Javaid, M., & Singh, R. (2022), Kasneci, E. et al. (2023), Lo, C. (2023), Qi, X., Zhu, Z., & Wu, B. (2023), Ray, P. (2023), Teubner, T. et al. (2023), Tlili, A. et al. (2023), Wood, D. et al. (2023), and Zhai, X. (2023).

The effect of ChatGPT and LLMs on the actuarial profession has been studied in several recent articles by Anonymous (2023), Jones, H., & McLeod, A. (2023), Kuppasamy, R., & Nkonyane, M. (2023), Lynch, J. (2023), Paczolt, M. (2023), Poon, J. et al. (2023a), Poon, J. et al. (2023b), Walmsley, J. (2023), but so far, no paper has considered the more narrow topic of how AI affects actuarial education. The thesis by Bloomfield, D. (1997) provides valuable insight into actuarial examinations, while information about actuarial science and the history of the profession can be obtained in Embrechts, P., & Wuthrich, M. (2022), Hickman, J. (2006), Klugman, S. (2016), and Lemaire, J. (2005). Actuarial education from a more traditional standpoint is covered in Mange, J. (2012) and Thomas, G. (2019). There are numerous sources dealing with the technical details of LLMs, so we will only reference Bommasani, R. et al. (2022), while the ethical dimensions are discussed in Eke, D. (2023), Khalil, M., & Er, E. (2023), Lund, B. et al. (2023), and Susnjak, T. (2022), among others.

THE LANDSCAPE OF ACTUARIAL EDUCATION

The earliest actuarial courses at American universities appeared around the start of the 20th century, but it took longer for actuarial science to be accepted as an academic discipline in its own right. One explanation is that it straddled two academic traditions but didn't fit neatly in either. Mathematical orthodoxy held actuarial science as an inferior field of study, because it lacked a formal axiomatic basis. Within business, actuarial science was the odd man out, with actuaries portrayed as overly technical and not sufficiently entrepreneurial.

Given the early deficit of academic standing, it is not surprising that actuarial education in the U.S. evolved around the organizations that were first formed to advance the interests of the actuarial profession, formulate standards of practice and a code of ethics, and provide continuing professional development. The first actuarial examination system was adopted in 1896 and the first actuarial journal published the same year; the first Fellow by examination qualified in 1900. Soon, textbooks and lectures were developed to assist those pursuing qualification.

It is worth noting that insurers were expanding already in the 1800's, but large catastrophes, mismanagement, and state regulation hampered the industry's growth, with the Great Depression causing huge investment losses. In the meanwhile, only a handful of employers in mining, steel, and railroads offered some sort of health insurance prior to the 1930's. That changed with the Social Security Act of 1935, which created a nationwide social insurance system to protect against disability or unemployment and to fund retirement benefits, while private insurance plans were adopted to secure steady revenue streams for hospitals and provide needed access to care. Then, in 1942, the Stabilization Act encouraged the creation of employer-sponsored health insurance and private pension plans as a way to compete for scarce workers without raising wages. As a result, the percentage of the population with insurance shot up from less than 10% before World War II to almost 70% by 1960.

Consequently, the demand for actuarial professionals exploded, and business leaders worked in concert with universities to sponsor academic programs that would train future actuaries. However, until recently, the majority of actuaries continued to be sourced from allied disciplines, such as mathematics or economics. Actuaries have remained a relatively obscure profession, notwithstanding being named the best job in America by the Jobs Rated Almanac and other career ranking publications, and despite the proliferation of actuarial science programs in recent years. The profession has also faced intense competition for talent from other fields: finance and economics from the 1980's till the Financial Crisis of 2007, and data science afterward.

As alluded to earlier, actuarial credentialing in the U.S. has generally been outside the domain of higher education. This is in contrast to the system in place throughout Continental Europe, where entrance to the actuarial profession is granted by universities and regulators rather than by professional actuarial organizations. However, the distinction has somewhat lessened in the last fifteen years, with the U.S.-based actuarial societies validating educational experience through completion of university courses, designing tiers of recognition for universities with actuarial programs according to the sophistication of their curricula, and lately even providing exam credit to students who perform well in pre-approved, actuarial society-monitored university courses. All of these initiatives have in turn incentivized universities to align their programs of study with the credentialing systems of the actuarial societies.

How the current education model works

The primacy of actuarial organizations in setting the educational model for qualification as an actuary has a number of important ramifications. We discuss several of them below.

- The first few actuarial exams are multiple-choice and focus on solving dozens of questions in a short amount of time. University programs are judged by how well their students fare in these exams, and hence professors are inclined to "teach to the test". This increases test anxiety and amplifies disparities of educational outcomes among different demographics. It also represents an opportunity cost—designing university courses with the goal of maximizing exam success and without, say, enough attention to critical thinking skills leads to future actuaries that struggle with ambiguous or open-ended real-life problems.
- A cottage industry of exam preparation publishers and tutors has emerged to help students and young professionals pass actuarial exams. Actuarial programs and professors can include these resources in class in an effort to better prepare students (and perhaps bargain with these vendors a more affordable price), or assume that students will use them on their own time and instead emphasize the critical thinking skills and other competencies not addressed by the exams. Most commonly, the first approach is taken.
- Many professors teaching actuarial science courses are either former actuaries, or academics whose scholarly interests lie in a different field of study. The practitioners' teaching tends to be informed by concrete applications rather than actuarial research or theory, while the non-actuarial academics may not discuss applications at all. The dearth of actuarial teacher-scholars outside the top actuarial programs in the U.S. and

the low diversity among them could also be contributing to the relative lack of creativity and adaptability in the actuarial profession.
- Exam dates and fees, testing center locations, scheduling issues, etc. represent an additional layer of complexity for underprivileged students who are trying to figure out college. Students are expected to have an exam by the beginning of their junior year to be competitive for summer internships, and those who fail to do so are at a disadvantage. Universities need to take these constraints into account when structuring their degree to increase the chance of their students graduating with jobs lined up.
- Later exams that purport to test actuarial knowledge as applied today are often badly outdated. For example, it has only been three years since exam logistics reached the point where candidates could utilize spreadsheet software, despite its availability and widespread use at the office for almost forty years. This issue is compounded by the fact that exams are written by a small number of volunteers who don't have the training to construct valid assessment instruments and whose grasp of the subject being examined may not exceed by much that of the candidates.
- Most importantly, there is no evidence to suggest that actuaries who pass their exams quickly are more competent at their job than those who struggle with them or who prioritize work commitments over studying. Even allowing for a weak positive correlation, the point still stands: should actuarial education be centered around an examination system that, at least beyond the first or second exam, doesn't measure work-relevant ability well?

This last observation parallels the debate about whether SAT scores are strong predictors of future success. But whereas SAT preparation for the typical student may take three to six months, the average travel time to full qualification is at least seven years, and consisting of about ten exams.

HOW LLMS CAN TRANSFORM ACTUARIAL EDUCATION

Let us explore the different ways that the availability of powerful LLMs like ChatGPT can impact actuarial education, by first considering the student's perspective. Imagine a student is taking a college course in actuarial science or is pursuing qualification with one of the actuarial societies, and she is interested in leveraging this new technology to her benefit. What that looks like would depend on the individual student, but a few possibilities are:

- To have ChatGPT do her homework and other assessments
- To ask ChatGPT to teach her the material that she is expected to know
- To engage ChatGPT in a process of discovery that goes beyond what's required for her classes

Professors may also think to incorporate ChatGPT in their daily work, in the following ways:

- As a teaching tool to enhance the learning experience and outcomes for their students
- As a virtual grader
- As an assistant in the development of lesson plans, notes, case studies or other course materials, or to help with the writing of papers, literature review, data analysis, etc.

It is inevitable that all of these ideas (and more!) will be tested in practice. One could say ChatGPT is the figurative genie that can't be put back in the bottle, and therefore we have to learn how to live with it. This boils down to two parts: how to make the most of the opportunities it opens up, and how to mitigate its potential for harm.

ChatGPT as a cheat code

Assessment of students is an integral component of any course, because it measures progress along the course's learning outcomes. It is also meant to help students gauge their own understanding of the material and effectiveness of their study habits. It follows that any technology that defeats the purpose of assessment is by default very disruptive to education. Therefore, it is crucial to carefully examine how standard assessment practices in actuarial science courses are affected by ChatGPT and related systems, and what would assessment look like in the future.

At the level of difficulty that is typical for actuarial exams in probability and financial mathematics, ChatGPT, in its current version, will confidently produce the wrong answer most of the time, however this assumes that the student didn't provide it with a similar question and its solution in the prompt. In other words, while ChatGPT is capable of zero-shot learning, mathematics is one of its weaker areas and some clever prompt engineering could go a long way to guiding the system to a correct solution. GPT-4 or ChatGPT with a Wolfram Alpha plugin could fare a lot better. In any case, it is safe to assume that soon, students will have access to a LLM that can effortlessly solve any such question.

For harder exercises, like those that could appear in later exams in life contingencies or loss models, the system may still make mistakes from time to time that will probably escape the student's attention. The other challenge is with the specialized mathematical notation that may be used in the statements of such questions, which would need to be described in words. However, this won't be an issue for LLMs like GPT-4 that can accept a screenshot of the statement as the input. It is as if the student is given a solutions manual that includes virtually all questions that can be asked in these subjects, and therefore the student's only contribution will be copying down (or copying and pasting) the answer.

To preserve the value of homework as a formative assessment instrument, the assignments should exceed what ChatGPT can do. If that's not possible, then perhaps the class could be flipped, with problem solving taking place in the classroom instead. This idea presents its own set of challenges, including whether it allows sufficient time to practice and how to assess in-class work. Another option is to in- corporate an oral defense as a way to validate the work that students turn in, or to provide students with solutions and make the oral defense the only assessment of homework. If face-to-face time doesn't suffice for this, it can be relegated to a synchronous online session.

Beyond homework, the disruptive potential of ChatGPT is even greater. Our experience shows that it can handle case studies better that homework sets because it gets more contextual information to base its response on. Similarly, ChatGPT with a file reader plugin can write detailed memos and data analyses that would satisfy most actuarial science projects. Code generation is an area where LLMs naturally excel, and thus any project that requires VBA, R, or Python code can be tackled. The one issue that has been identified in the literature, namely, the inability of ChatGPT to provide valid citations, appears to be something that can be addressed with a search engine plugin. Not to mention that students could always add plausible references at the end, hoping that the professor won't bother to look them up.

The educational value of case studies and projects in actuarial science necessitates that we find a way to make them ChatGPT-proof. One idea is to build these cases or projects around events that have occurred after September 2021, but there is no guarantee that a search engine-enhanced ChatGPT won't be able to find information about them. Moreover, ChatGPT can't execute code, which implies that any data analysis project will be missing all inferences as well as the graphical elements (bar charts, scatterplots, etc) that one would expect in a report. However, integration with a Python interpreter and other statis- tical software will be coming soon, so this doesn't appear to be a durable limitation to rely upon.

Perhaps the biggest give-away is ChatGPT's distinct voice as a writer that a professor could learn to recognize and which would help identify similarly worded essays as machine-generated. The professor could also disincentivize the use of ChatGPT by penalizing essays that are too formulaic and don't re- flect in any way the discussion in class. Indeed, some professors may opt to forbid any use of AI, but in that case, accurate detection and enforceability of such a rule are not straightforward. Even for essay questions, current plagiarism detectors, such as TurnitIn, may not always produce reliable results, since there is no single original source to compare against.

This topic is also of concern to actuarial societies in regard to their examination systems. While the exams themselves take place in a controlled environment where candidates have no access to AI-powered tools, actuarial credentialing requires the completion of several e-learning modules as well. Each of them culminates in a memo or written report, and it is possible that a candidate could circumvent the learning part and generate the reports with the help of ChatGPT.

ChatGPT as a tutor

Students taking this approach would utilize ChatGPT in a way that helps them learn better. For example, they could ask the system to give definitions or additional explanations of probability concepts that were discussed in class, or to walk them through a solution step-by-step of all in-class examples in financial mathematics. ChatGPT could also easily rephrase or summarize parts of an actuarial textbook, and it could create flashcards or Cliffs notes. Giving it access to a problem-and-solution set, like those made available by the actuarial societies, it could generate similar questions for the student to practice on, or it could comment on how they relate to actuarial practice.

Other productive uses that a student may attempt include to ask ChatGPT to identify the theory that is needed to understand and solve an actuarial exam question, to state any relevant theorems or mathematical formulas, to submit an essay on risk and insurance to be checked for grammatical or syntax errors and to make corrections, to propose a structure for an actuarial report or memo, to write a review of the historical development of a topic or an area of study such as survival models, to produce code in any computer language from instructions or pseudocode, to annotate existing code so that anyone can understand what it does, to translate technical terms in actuarial science or other field to any human language, or to write code in a different computer language than the one it was given.

It bears repeating that the quality of the output will critically depend on how much detail is provided in the prompt. And although LLMs are able to explain why a joke is funny, it shouldn't be expected that ChatGPT will display the specificity, perception, and judgement that a human tutor would. On the other hand, the around-the-clock availability of ChatGPT and its capacity to draw connections across disciplines can't be easily beat. Students, being naturally receptive to and curious about new technologies, may gravitate to the AI-as-a-tutor model because it is cost effective (or free), it doesn't run against any stated or implicit academic honor codes, it is always good-mannered, and it causes no embarrassment if the student makes a mistake.

ChatGPT as a learning partner

Using ChatGPT as a tutor makes sense if we assume that the model will get virtually all answers right. But a more enriching experience can be had if the student is inclined to not always believe the model's output and instead maintain a critical view. This could take the form of dialectic interrogation, where the student asks a series

of probing questions that reveal the model's shortcomings in reasoning or knowledge, forcing it to contend with them and search for a better answer.

We illustrate this approach with an example: The student will ask ChatGPT to perform non-trivial work, such as to write Python code for a Monte Carlo simulation that approximates the number e. The model, drawing from its training data, may produce a simulation that approximates π instead (which is an easier task, and something that's well-known). Or it may cheat and write code that approximates e through its definition as a limit, but not as a Monte Carlo simulation. In either case, the student can point out the mistake and ask for a corrected answer. If the model vacillates between incorrect answers, the student can provide another example of a well-executed Monte Carlo simulation to inspire better results. Or she can offer a human solution to the initial prompt and ask if it is correct and why it works.

To clarify, not every question will be within ChatGPT's ability to reason it out, which we call its cognitive envelope, regardless of how granular the prompts are. The afore-mentioned task still eluded ChatGPT after a back-and-forth of considerable length, although it was able to explain why a correct solution worked after a few hints. GPT-4, on the other hand, was able to give a superior response to the one provided by the author, but still struggled with parsing our solution. In both cases, validating the model's work and digging deeper into its reasoning proved to be enlightening.

ChatGPT as a teaching tool

If students aren't self-motivated to do inquiry-based learning on their own, perhaps professors can nudge them in that direction with the help of ChatGPT. The most obvious way is to provide students with a series of prompts, like "Explain how an infinite geometric series can have a finite sum", "How is the geometric series used in financial mathematics and, in particular, annuities?", and "Can you derive the formula for the present value of an annuity-due from first principles?". Certainly, the amount and specificity of the prompts can be adjusted to give students more ownership over this inquiry into the theory of annuities so as not to steal the joy of discovery or shortcut their opportunity to draw connections.

The above example shows one of many ways to purposefully utilize ChatGPT in the learning process. From the professor's perspective, encouraging the use of ChatGPT at home can assist with personalized instruction and adaptive learning. Students can interact with ChatGPT at their own pace and convenience, promoting engagement and flexibility for all types of learners. Class time can then be devoted to discussion, synthesis, and application of the theory, which represent higher-order thinking skills than retrieval of information and basic comprehension.

Now assume that today's class is about the application of GLMs in loss reserving and the professor wants to demonstrate how the ultimate losses are computed. By using a prompt such as "Write Python code that uploads a hypothetical dataset loss.csv consisting of reported losses per accident year and per development year and applies GLM methods to compute ultimate losses", the class gets executable code that can be copied into a Python compiler, but also explanations about link functions and other distributional assumptions. Even if there is a bug in the code, ChatGPT can do the debugging.

A few more ideas for interacting with ChatGPT in a fruitful way during lecture are: to give students a few minutes to research today's topic prior to lecturing, to ask them to attempt a challenging exercise with the help of ChatGPT, to have them interrogate it after learning about a topic, or even to generate a joke as a way of using humor to divert the conversation from a somber topic such as mortality and morbidity.

ChatGPT as a virtual grader and assistant

ChatGPT is uniquely positioned to serve as a virtual grader. Professors can write the grading rubric and let the model evaluate students' submissions on it, followed by sending them extensive feedback. This can be implemented equally well for creative work, such as memos and project reports, and for more pedestrian assignments, such as the grading of exams. Additionally, it offers the promise of detecting plagiarism more effectively than the leading non-AI systems of today.

Leveraging ChatGPT's language generation capabilities, professors can create teaching materials of all sorts. It can digest whole book chapters and turn them into slides to be used during lectures, it can assist with finding or generating relevant examples or case studies, it can help develop worksheets, and it can even write homework assignments, exams, and other assessments. The key to accomplishing all of these tasks is to use sufficiently detailed prompts and to enable plugins that will allow the model to get help with web searches or with math calculations.

Moreover, ChatGPT can help professors formulate a research plan and make progress with their writing. A number of journal articles have already appeared with co-author credits to ChatGPT, but many more have relied on AI to summarize existing research so that it can be quickly read by the researcher.

AI can also revolutionize the actuarial credentialing system. A suitably fine-tuned LLM can generate better exam questions across all actuarial exams. This will unburden the volunteers, who could then help as human trainers and monitors, and will ensure better consistency and quality control. The same LLM can provide instantaneous personalized feedback to candidates after grading their papers, cutting the wait time from about ten weeks to mere seconds. Lastly, it can permit the administration of exams at more frequent times, and, at the same time, significantly reduce their cost.

THE EFFECTS ON ACTUARIAL PRACTICE

Every technological innovation of import to actuarial science was embraced by insurers and other employers of actuaries well ahead of its adoption by the actuarial societies in their credentialing systems or its appearance in actuarial education. We have mentioned spreadsheets before, but the same applies to macros, programming languages such as R or Python, or machine learning. And the same will be true for AI and ChatGPT. Companies are already looking for productivity gains and automation of repetitive and low-yield jobs that are still plentiful within the industry. ChatGPT's ability to perform calculations, provide insights, and generate reports quickly and accurately will streamline actuarial processes and make the future actuarial work more interesting and varied.

The availability of opportunities and progression of actuarial talent will also be disrupted, while experienced professionals will become more productive and thus more valuable. Senior actuaries who sign rate filings or statements of actuarial opinion will be safe, but junior actuarial analysts will have to compete harder. Particularly for computer and data scientists who don't possess domain knowledge in insurance, the deployment of ChatGPT will be detrimental. Claims adjusters and underwriters working with standard lines, or data entry, customer service, and administrative personnel will also be seriously impacted.

Ultimately, the adoption of AI tools like ChatGPT may lead to a bifurcation within companies and across the industry. Organizations that embrace and integrate AI technologies will likely experience a shift in skill requirements and work processes. Actuarial practices will evolve differently based on their level of AI adoption,

potentially creating disparities in the strategic directions and profitability of various companies that will ultimately determine their viability in the market.

A BRIEF DISCUSSION OF ETHICS

Another aspect of the AI revolution that concerns us all has to do with the ethical and legal implications of this technology. The issues that arise from the use of ChatGPT have to do, not only with potential academic honor code violations, but also with copyright, ownership, safety, and the perpetuation of bias. We briefly address each of these below.

The issue of copyright starts with the indiscriminate collection of the intellectual property of millions and usage in the training of an AI model that is owned by a company like OpenAI. How do copyright protections apply in this case, and should there be any sort of limitation in how the output of the model is used, given its status as a derivative work? The lack of transparency as to how exactly the model learns from data and the endless potential applications make this a gray area that requires our good judgement.

A related consideration is about acknowledgement of ownership of the model's output. One approach would be to consider any text generated by ChatGPT to be a direct consequence of the prompt provided by the user, and therefore also belonging to her, while another approach would recognize the fact that the output represents a combination of knowledge and reasoning that didn't originate with the user and hence has to be attributed appropriately.

The misuse of models such as ChatGPT can also open the door to issues of bias and safety. Despite its careful fine-tuning, any such model runs the risk of being jail-broken, which can then generate output that is harmful or dangerous. Who is accountable if actual harm were to occur? A related technique, prompt injection, also results in hijacking the model to control its behavior. But even without tampering with it, the model by itself is capable of regurgitating the bias that is present in its training data and presenting it as objective truth.

CONCLUSION

The recent emergence of LLMs and ChatGPT is expected to have a profound impact in our lives and the way we perform our work. In this article, the focus was on how actuarial science, both as an academic discipline as well as a profession, will be affected. We explored ways to harness this new technology so that we enhance actuarial education, while at the same time seeking to limit the potential for harm. As the rate of adoption goes up and the old paradigms become untenable, we ought to be proactive and open to recalibrating our approach to ensure we attain these goals.

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A Research Project Based on the CDC Requirements for Immunization Information Systems for the COVID-19 Response

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ABSTRACT

As of March 2023, the U.S. government has spent $25.3 billion to purchase 1.2 billion doses of the Pfizer and Moderna COVID-19 vaccines combined. This government-led vaccine distribution was unprecedented in both scale and time frame. Meticulous planning was required of many public and private partners**. In particular, the** Centers for Disease Control and Prevention (CDC) issued a playbook to guide jurisdictions' vaccination response efforts. I developed a research project based on the CDC requirements for jurisdictions' immunization information systems. The project asks students to pick a jurisdiction and a required CDC activity and analyze the project risk management of the chosen activity.

MOTIVATION FOR THE RESEARCH PROJECT

The COVID-19 pandemic that broke out in late 2019 caused unprecedented disruption to the world. As drug companies raced to develop vaccines in the early months of the pandemic, the U.S. government worked to ensure large-scale and smooth distribution of vaccines when they became available for public use. Michaud and Kates (2020) write about the vaccine distribution, "It will be a historically complex challenge to ensure that enough vaccines are distributed in a rapid, effective, and equitable way. The U.S. has some experience with mass vaccine distribution to build on and has faced some of the challenges before, but delivering COVID-19 vaccines will need to be at a much greater scale than past efforts, and will also bring new and unique challenges."

To that end, on May 15, 2020, the U.S. government launched Operation Warp Speed (OWS), a multi-agency public–private partnership led by the Department of Health and Human Services and the Department of Defense, with the goal of developing, producing, and distributing COVID-19 vaccines. Michaud and Kates (2020) highlight the key developments that happened in the months following OWS's establishment: "On August 4, the Centers for Disease Control and Prevention (CDC) provided state and local health departments with interim vaccine planning assumptions and action steps to inform development of COVID-19 pandemic vaccination plans. Actual planning documents were provided to health authorities on August 27; at this time, CDC also sent a letter to governors asking them to ensure distribution sites in their states could be operational by November 1. OWS provided Congress with a federal vaccine distribution strategy, and CDC released an interim playbook for jurisdiction operations on September 16. In the playbook, CDC says jurisdictions are required to develop and submit vaccination plans by October 16, 2020. Finally, on September 23, HHS announced that it was providing $200 million to state and local jurisdictions specifically for vaccine preparedness."

On December 11, 2020, the U.S. Food and Drug Administration (FDA) granted Emergency Use Authorization (EUA) for the Pfizer-BioNTech COVID-19 Vaccine. As of March 2023, **"**The federal government has so far purchased 1.2 billion doses of Pfizer and Moderna COVID-19 vaccines combined, at a cost of $25.3 billion," according to Kates, Cox, and Michaud (2023).

Michaud and Kates (2020) note that the unprecedented number of doses far exceeded what had been done in the past: **"**Government-led vaccine distribution in the timeframe and at the scale being contemplated for COVID-19 has never before been done in the U.S., with hundreds of million doses needing to be distributed, over as short [a] period of time as possible, in order to vaccinate most of the U.S. population. In contrast, in a typical year, CDC distributes about 75 million vaccine doses to health departments and private providers. In the context

of the H1N1 pandemic during 2009–2010, the government distributed 124 million doses of the H1N1 pandemic influenza vaccine over the course of several months."

The sheer number of doses undoubtedly called for meticulous planning. The CDC playbook mentioned by Michaud and Kates (2020), formally titled "COVID-19 Vaccination Program Interim Operational Guidance Jurisdiction Operations,"[13] required the 64 jurisdictions it funds and works with to set up their own vaccination plans and undertake certain activities.

As I read the playbook, I was in awe of the tremendous amount of effort that went into the vaccine response task. At the time, I happened to be thinking about developing a new project for my graduate-level project risk management course. I realized the playbook provided a great opportunity for risk management analysis, so I wrote a group project based on it. The rest of the article offers some more background information and a detailed explanation of the project.

CDC PLAYBOOK AND ITS SUPPLEMENTAL DOCUMENT "PREPARING IISS FOR COVID-19 RESPONSE"

The CDC playbook noted that the goal of the U.S. government was "to have enough COVID-19 vaccine for all people in the United States who wish to be vaccinated." The playbook served as a foundation "for state, territorial (including the US-affiliated Pacific Islands [USAPI] of American Samoa, the Commonwealth of the Northern Mariana Islands, Guam, the Federated States of Micronesia, the Republic of the Marshall Islands, and the Republic of Palau), tribal, and local public health programs and their partners on how to plan and operationalize a vaccination response to COVID-19 within their jurisdictions." The document covered "specific areas of COVID-19 vaccination program planning and implementation and provided key guidance documents and links to resources to assist those efforts."

In order to achieve this goal, the CDC required jurisdictions to meet various requirements, which were detailed in the playbook's 15 sections:

- Section 1: Public Health Preparedness Planning
- Section 2: COVID-19 Organizational Structure and Partner Involvement
- Section 3: Phased Approach to COVID-19 Vaccination
- Section 4: Critical Populations
- Section 5: COVID-19 Vaccination Provider Recruitment and Enrollment
- Section 6: Understanding a Jurisdiction's COVID-19 Vaccine Administration Capacity
- Section 7: COVID-19 Vaccine Allocation, Ordering, Distribution, and Inventory Management
- Section 8: COVID-19 Vaccine Storage and Handling
- Section 9: COVID-19 Vaccine Administration Documentation and Reporting
- Section 10: COVID-19 Vaccination Second-Dose Reminders
- Section 11: COVID-19 Requirements for Immunization Information Systems or Other External Systems
- Section 12: COVID-19 Vaccination Program Communication
- Section 13: Regulatory Considerations for COVID-19 Vaccination
- Section 14: COVID-19 Vaccine Safety Monitoring
- Section 15: COVID-19 Vaccination Program Monitoring

While any of the sections could be used to develop risk management projects, I came across a supplemental document, "Preparing IISs for COVID-19 Response,"[14] that provided a more in-depth look at the

[13] https://www.cdc.gov/vaccines/imz-managers/downloads/COVID-19-Vaccination-Program-Interim_Playbook.pdf
[14] https://www.cdc.gov/vaccines/covid-19/reporting/downloads/Master-Awardee-Work-Plan.pdf

required immunization information system (IIS) activities in Section 11. As such, my project was based on Section 11 in the playbook and the supplemental document.

IISs, also known as "vaccine registries," are managed by jurisdictions' immunization programs. IISs are essentially databases that record confidential information on vaccine doses. According to the playbook, "In many jurisdictions, routine vaccination providers enroll in public vaccine programs, order vaccines, report inventory, document vaccine spoilage/wastage, and remind patients when vaccine doses are due using the IIS. Using the IIS to document COVID-19 vaccine dose administration is beneficial on many fronts. When using the IIS, vaccination providers are able to determine if a patient is due for the first or second dose of a vaccine. This is especially helpful in a pandemic situation when people may receive first and second vaccine doses at different locations. The IIS will also help to ensure that first and second doses are administered using the same vaccine product and appropriately spaced according to ACIP-recommended intervals.[15] Based on a jurisdiction's discretion and IIS functionality, COVID-19 vaccination providers may use IISs to:

- Preregister or enroll in the COVID-19 vaccination program
- Place orders for COVID-19 vaccine
- Document vaccine administration
- Manage and report vaccine inventory
- Report vaccine spoilage/wastage
- Provide reminders to COVID-19 vaccine recipients indicating when the next dose of a multidose vaccine is due"

The supplemental document detailed the following 10 activities in four categories (page 2) required of jurisdictions to ensure their IISs' functionality or ability to collect, submit, and exchange COVID-19 vaccination data.

- System Infrastructure
    1. Update system and improve capacity: jurisdiction's IIS infrastructure meets COVID-19 response data exchange, storage, and reporting requirements.
    2. Address defects and enhancements: jurisdiction's IIS operates as expected to support COVID-19 vaccination tracking efforts.
    3. Adopt vaccine administration tracking method: jurisdiction implements a vaccine administration tracking method that meets defined standards.
- Partner and Provider Preparation
    4. Target critical populations: jurisdiction identifies mechanisms to reach critical populations during early targeted vaccination efforts.
    5. Conduct provider outreach: jurisdiction has optimal provider participation in IIS for early critical and general population vaccination efforts.
    6. Enroll and onboard providers: jurisdiction enrolls and onboards providers to COVID-19 vaccination program and IIS for timely data exchange.
- Data Management
    7. Align and implement policies for data sharing.
    8. Collect and report data: jurisdiction's IIS collects, reports, and submits data to satisfy CDC and jurisdictional reporting requirements.
    9. Improve data quality: jurisdiction's IIS data quality meets defined standards for the COVID-19 response.
- Ordering and Inventory
    10. Manage vaccine ordering and inventory tracking: jurisdiction has processes for allocating vaccine to provider sites and tracking inventory.

[15] ACIP is Advisory Committee on Immunization Practices, part of CDC.

Each of the activities in itself was a project to be carried out. My class project asks each research group to pick a jurisdiction and an activity from the list and analyze the jurisdiction's project risk management of the chosen activity.

BACKGROUND OF MY CLASS

I teach a graduate-level 7-week asynchronous online class in project risk management every spring semester. I developed the project in Fall 2020 and have been using it since Spring 2021. My students commented that the project was timely, relevant, and interesting because the whole pandemic situation was still unfolding when we did the project in 2021 and 2022. The federal Public Health Emergency (PHE) expired on May 11, 2023, nine days after the conclusion of my Spring 2023 class. While the pandemic is behind us, I'll continue to use this project in my class, as it is a great case study in project risk management.

I have two required textbooks for the class: *A Guide to the Project Management Body of Knowledge (PMBOK® Guide – Sixth Edition)* (ISBN: 9781628251845) and *Practice Standard for Project Risk Management* (ISBN-13: 9781933890388).

According to *Practice Standard for Project Risk Management* (page 16), the project risk management process involves the following steps:

- Plan risk management – "Defines the scope and objectives of the Project Risk Management process, and ensures that the risk process is fully integrated into wider project management."
- Identify risks – "Identifies as many knowable risks as practicable."
- Perform qualitative risk analysis – "Evaluates key characteristics of individual risks, enabling them to be prioritized for further action."
- Perform quantitative risk analysis – "Evaluates the combined effect of risks on the overall project outcome."
- Plan risk responses – "Determines appropriate risk response strategies and actions for each individual risk and for overall project risk, and integrates them into a consolidated project management plan."
- Monitor and control risks – "Implements agreed-upon actions, reviews changes in project risk exposure, identifies additional risk management actions as required, and assesses the effectiveness of the Project Risk Management process."

My project requires students to team up and do a project risk management analysis of their chosen jurisdiction's chosen IIS activity.

THE PROJECT

The detailed instructions for the project[16] are included in the appendix. I highlight some key points in this section.

This project follows the project risk management process mentioned above, with the exception of quantitative risk analysis. I have a separate assignment that requires students to do quantitative risk analysis, such as Monte Carlo simulation. For this group project, I ask students to focus on qualitative risk analysis.

The flow of the analysis goes like this: choose a jurisdiction → pick an IIS activity → do a stakeholder analysis → define risk probability and impact rating scales, as well as risk assessment criteria → identify risks → conduct qualitative risk analysis → plan risk response → summarize findings and offer recommendations.

[16] I did not include the grading criteria of the project as that is instructor-specific.

The CDC required all of the jurisdictions it funded, 64 in total, to meet the IIS activity requirements mentioned above. The jurisdictions include the 50 states, Washington, D.C., the U.S. Virgin Islands, Puerto Rico, the N. Mariana Islands, the Marshall Islands, American Samoa, Guam, Palau, Micronesia, San Antonio, New York City, Houston, Chicago, and Philadelphia. Students can choose any of the 64 jurisdictions. The CDC has each jurisdiction's vaccination plan executive summary,[17] but there are no full texts corresponding to the summaries. Students are also advised to read the Kaiser Family Foundation (KFF) report,[18] which maintains a list of each state's detailed vaccination plan.[19]

As mentioned above, there were 10 required IIS activities. Each research group is free to pick any activity.

Project stakeholders possess different amounts of power and exhibit different levels of interest. Therefore, it is critical to identify key stakeholders in project management. I ask students to identify one example of stakeholders in each cell of the power/interest grid that may affect their chosen activity: high interest and high power; high interest and low power; low interest and high power; low interest and low power.

Students are next asked to define their risk probability and impact rating scales (such as 1–5 representing least likely to most likely for probability, and 1–5 representing minor impact to significant impact on project outcomes), as well as risk assessment criteria, which will then be used to assess each individual risk. The risk assessment criteria are based on risk scores (which are risk probability scale times risk impact scale). If we use a 1–5 scale for both probability and impact, then risk scores go from 1 to 25. Students are free to define their own risk assessment criteria based on stakeholders' risk appetites. For instance, a risk score of 1–5 may be deemed low risk, a score of 6–15 medium risk, and a score of 16–25 high risk. I included examples of how to define risk assessment criteria in my project instructions.

While I referred to *A Guide to the Project Management Body of Knowledge* (PMBOK® Guide – Sixth Edition) in my instructions on how to define a risk probability scale, a risk impact scale, and risk assessment criteria, I also gave additional detailed examples to demonstrate how to do this part. Therefore, instructors who teach risk management courses and use different textbooks should have no problem adopting this project.

I ask each group to identify nine major risks that may affect their chosen activity, with three mainly influencing the cost of the activity, three mainly influencing the performance/quality of the activity, and three mainly influencing the schedule of the activity. For each risk, students are asked to evaluate and justify its risk probability and impact rating and calculate its risk score. Once risk scores are calculated, students are asked to plot them on a color-coded risk map based on their risk assessment criteria.

For the top three risks with the highest risk scores, students are asked to identify risk responses. After that, they summarize their findings and make recommendations for their chosen jurisdiction's chosen activity.

CONTINUED RELEVANCE OF THE PROJECT

Leung and Nicoll (2010) note, "There is general consensus that the only predictable characteristic of influenza viruses and pandemics is [their] unpredictability." As such, it is always important to learn from past experiences to better prepare for future outbreaks. For instance, the U.S. Government Accountability Office issued a report (GAO, 2011) titled "Lessons from the H1N1 Pandemic Should Be Incorporated into Future

[17] https://www.cdc.gov/vaccines/covid-19/covid19-vaccination-guidance.html. Note: you need to click on "jurisdiction" in the middle of the page to expand it and see all jurisdictions there.
[18] https://www.kff.org/coronavirus-covid-19/issue-brief/states-are-getting-ready-to-distribute-covid-19-vaccines-what-do-their-plans-tell-us-so-far/
[19] https://www.kff.org/report-section/states-are-getting-ready-to-distribute-covid-19-vaccines-what-do-their-plans-tell-us-so-far-state-plans/

Planning" after the 2009 H1N1 influenza pandemic. The report notes that the government had a budget of $6.15 billion for the H1N1 pandemic response. In comparison, the government has spent at **least** $25.3 billion as of March 2023 just to purchase COVID vaccines (Kates, Cox, and Michaud, 2023). The CDC playbook correctly predicts that "Many of these [pandemic vaccination response] partners are engaged regularly in seasonal influenza and other outbreak vaccination campaigns, and many served as vaccination providers during the 2009 H1N1 pandemic. However, significant additional planning is needed to operationalize a vaccination response to COVID-19, which is much larger in scope and complexity than seasonal influenza or other previous outbreak-related vaccination responses."

The playbook also predicts that, "Ultimately, COVID-19 vaccine will be widely available and integrated into routine vaccination programs, run by both public and private partners."

The World Health Organization (WHO) ended the global emergency status for COVID-19 on May 5, 2023, and the U.S. government ended the federal Public Health Emergency six days later. This, however, does not mean that COVID is no longer a global health threat. Tedros Adhanom Ghebreyesus, WHO Director-General, said at the press conference to declare an end to COVID-19 as a global health emergency, "It is still killing and it is still changing. The risk remains of new variants emerging that cause new surges in cases and deaths."[20]

Given the above, managing infectious diseases, outbreaks, or pandemics remains a top public health priority. As such, the project I designed for my project risk management course remains relevant.

EXPANSION OF MY PROJECT

My project was specifically designed for my graduate-level online project risk management course, but it can also be used in other risk management courses at both undergraduate and graduate levels, be they in-person or online.

Different risk management courses may use different textbooks than the two books used in my project risk management course, and there may be some subtle differences, such as the detailed steps to follow in the risk management process. However, the main risk management principles covered are essentially the same, and instructors can easily make minor changes to my project to suit their specific courses.

I give my students the freedom to choose their jurisdiction and IIS activity. There are 64 jurisdictions and 10 activities, resulting in 640 different combinations. I find it very interesting reading students' papers covering different jurisdictions and different activities. They have shown that different jurisdictions faced unique challenges and utilized some unique means to meet the CDC requirements.

Instructors may also want to require all students to work on the same jurisdiction but different IIS activities. This way, they can see how the same jurisdiction was doing in getting its IISs ready for its vaccination response efforts.

Instructors could also require all students to work on the same activity but different jurisdictions. The CDC playbook notes that "State governance structures vary from centralized to decentralized. In a centralized state, legal authority is concentrated in the central state government, which makes decisions and performs most functions. Conversely, in a decentralized state, authority and responsibilities are dispersed and distributed across regions and areas." Having students compare and contrast different jurisdictions in their undertaking of the same activity can help students see how state and local authorities combine and coordinate efforts given their unique governance structures.

[20] https://news.un.org/en/story/2023/05/1136367

Another way to expand my project is to look at CDC requirements in areas other than IISs. My project focuses on Section 11 of the playbook, but there are many other sections mentioned earlier in the article. These other sections could also be used to follow the same setup as my project.

Since my project risk management course is a 7-week online class, the only project deliverable is a written paper. Instructors whose classes span a whole semester and/or are in-person may want to modify the project deliverables by requiring oral presentation in front of the class, critiquing each other's risk analysis, and/or adding other requirements.

Instructors may also use just part of my project to facilitate their classroom discussions. For instance, I also teach two in-person undergraduate-level risk management courses (one focusing on the principles of insurance, the other on general risk management principles). While I do not require my undergraduate students to do the same project, I do use different parts of the project from time to time when I cover relevant topics. For instance, when I discuss setting objectives as part of the risk management process, I ask students to identify key stakeholders involved in a certain IIS activity. When I discuss risk maps in my undergraduate classes, I give some examples of COVID vaccine preparation efforts and ask students to identify relevant risks and evaluate their risk probability and impact.

In summary, my project has helped my students better understand the general risk management principles and their applications in project risk management. I hope other instructors find it helpful in their courses too.

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APPENDIX: RESEARCH PROJECT

Background Information

- According to the U.S. Centers for Disease Control and Prevention (CDC), "Providing COVID-19 vaccines nationwide requires unprecedented logistics and coordination effort among public health authorities and private-sector partners. Integrated IT systems—both public and private, as well as new and existing—are used to ensure successful vaccine allocation, distribution, administration, monitoring, and reporting."
- There are several systems currently in place that support vaccine logistics and administration, including the Vaccine Tracking System, Immunization Information Systems (IISs), VaccineFinder, and Immunization (IZ) Gateway. Among these systems, "Information Systems (IISs) were formerly known as 'immunization registries.' All 64 jurisdictions have or will soon have web-based IISs. Some IISs are hosted by vendors in the cloud, while others use secure servers housed by the jurisdiction." [Note: the 64 jurisdictions include the 50 states, Washington D.C., the U.S. Virgin Islands, Puerto Rico, the N. Mariana Islands, the Marshall Islands, American Samoa, Guam, Palau, Micronesia, San Antonio, New York City, Houston, Chicago, and Philadelphia.]
- To prepare for the publicly funded COVID-19 vaccines' allocation, distribution, administration, monitoring, and reporting, the CDC requires that each jurisdiction meet certain requirements, which are detailed in "COVID-19 Vaccination Program Interim Playbook for Jurisdiction Operations." Section 11, "COVID-19 Requirements for Immunization Information Systems or Other External Systems," in the playbook specifies the requirements for the IT system. "Preparing IISs for COVID-19 Response" further elaborates on the IT system requirements.
- While the CDC has each jurisdiction's vaccination plan executive summary, no full texts corresponding to the summaries are available. To assess each state's readiness, a Kaiser Family Foundation (KFF) report compiled a list of each state's detailed vaccination plan.

Research Task

- Your task is to read the above information (including the hyperlinked pages) and conduct a risk management analysis of a chosen activity required to get a chosen jurisdiction's IISs ready for the COVID-19 response.

- This research project is a team work. Students are expected to contribute their fair share to the project. **The final deliverable, due by 11:59 p.m. on 5/2/2023, is a research paper that meets the following requirements**. I've also included notes (after the requirements section) to offer more instructions.

  - **Structure of the Paper**
    - ***Cover Page:*** list the title and the authors of the research paper on this page.
    - ***Executive Summary*** *(i.e., abstract)**:*** summarize your key findings and recommendations in this section.
    - ***Introduction:*** give an overview of your chosen jurisdiction's COVID-19 vaccination plan and current status of plan implementation. Also, discuss your chosen activity and its scope as it applies to your chosen jurisdiction.
    - ***Stakeholder Analysis:*** for your chosen activity, identify one stakeholder in each of the following categories (refer to Week 3 course materials): high interest and high power, high interest and low power, low interest and high power, and low interest and low power. Discuss why the stakeholders fall in specific interest/power grids.
    - ***Definitions of Risk Probability and Impact:*** define risk probability and impact levels as well as risk assessment criteria that reflect your stakeholders' risk appetite and are specific to your chosen activity.

- ***Risk Identification:*** identify and discuss nine major risks that may affect the performance/quality, cost, and schedule of your chosen activity. Note that your risks should be jurisdiction-specific, not just general risk categories.
- ***Qualitative Risk Analysis:*** conduct a qualitative analysis of your nine risks. More specifically, discuss each risk's probability and impact ratings given your definitions of risk probability and impact, calculate its risk score, and plot it on a risk map (probability–impact matrix). Be sure to justify each risk's probability/impact ratings.
- ***Risk Response:*** for each of the top three risks (by risk scores), discuss two examples of risk response strategies that have been used by your jurisdiction or may be used to manage the risk. As discussed in the textbooks, these strategies include the following: avoid a threat or exploit an opportunity, transfer a threat or share an opportunity, mitigate a threat or enhance an opportunity, accept a threat or an opportunity. Be sure to offer specifics instead of just listing the names of the strategies. For instance, if you plan to purchase insurance to transfer a certain risk, you should offer specifics, such as what kind of insurance to purchase to cover what types of losses. Or if you want to use risk mitigation, you should discuss what kind of mitigation methods you may use.
- ***Conclusion and Recommendations:*** summarize your findings and offer recommendations to your chosen jurisdiction on how it can best manage risks related to your chosen activity.
- ***References:*** in this section, you should include a list of references you have cited in the text.
- ***Appendix:*** your report must include documentation of teamwork (use the templates included at the end of this document).

♦ **How to choose a jurisdiction?**

- You can choose from any jurisdiction listed in the abovementioned executive summary. It'd be best to pick a jurisdiction for which you can gather the most information for this research project. The KFF list of detailed vaccination plans should help you select a jurisdiction.

♦ **How to choose an activity?**

- The aforementioned "Preparing IISs for COVID-19 Response" has a list of activities required for each jurisdiction to meet the IT requirements for the COVID-19 response. The 10 required activities are on page 2 of the document and include: 1) update system and improve capacity, 2) enroll and onboard providers, 3) address defects and enhancements, 4) align and implement policies for data sharing, 5) adopt vaccine administration tracking method, 6) collect and report data, 7) target critical populations, 8) improve data quality, 9) conduct provider outreach, and 10) manage vaccine ordering and inventory tracking.
- Each required activity is in fact a project. You may choose any of the 10 activities.

♦ **How to identify risks?**

- You should identify at least nine major risks that may affect your activity. The risks could be either threats or opportunities.
- More specifically, three risks should mainly influence the activity quality/performance, three risks should mainly influence the cost, and three risks should mainly influence the schedule.
- While the same risk may affect quality, cost, and schedule at the same time, you should identify risks that mainly affect one of the dimensions. For instance, a construction project may be paused temporarily due to inclement weather. It will cause a schedule delay but may not necessarily affect project quality or cost that much.
- The following sample worksheet may help better understand the selection and identification process.

Jurisdiction	Activity categories	Risk	Quality/performance	Cost	Schedule
NY	Target critical populations	R1	x		
		R2	x		
		R3	x		
		R4		x	
		R5		x	
		R6		x	
		R7			x
		R8			x
		R9			x

- **How to define risk probability and impact?**

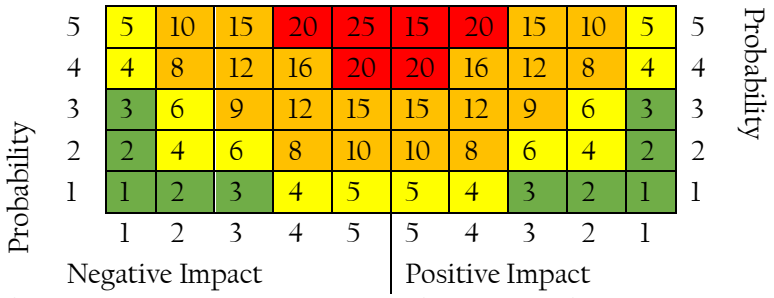
  - Table 11-1, "Example of Definitions for Probability and Impacts," on page 407 in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide – Sixth Edition)* offers an example.
  - Risk Assessment in Practice offers another example. Its "Illustrative Impact Scale" (on page 4) and "Illustrative Probability Scale" (on page 5) are both five-level scales, with the descriptors "rare, unlikely, possible, likely, and frequent" for probabilities and "incidental, minor, moderate, major, and extreme" for impact.
  - You are free to define your risk probability and impact, but you are expected to indicate probability/impact ratings (a numerical scale), descriptors, and detailed descriptions of each rating scale.

- **How to define risk assessment criteria?**

  - Figure 11-5, "Example Probability and Impact Matrix with Scoring Scheme," on page 408 in *A Guide to the Project Management Body of Knowledge (PMBOK® Guide – Sixth Edition)* shows a three-level risk scale (three colors shown there). To help you better understand the concept, I'm including a made-up example with a four-level risk scale here.
  - Let's assume we use a 1–5 rating scale for both probability and impact. Then, the risk score (=probability rating * impact rating) ranges from 1 to 25. My four-level risk assessment criteria (or risk scale) are shown below. Note I have four different colors here. Risks in the red zone warrant the most attention, as they are either threats that pose the greatest risk or opportunities that deserve to be fully explored.

Risk score range	Threats	Opportunities
0≤risk score≤3	low risk	little opportunity
4≤risk score≤6	medium risk	good opportunity
7≤risk score≤16	high risk	great opportunity
17≤risk score≤25	very high risk	excellent opportunity

- Once I have determined the risk scale, I then have the following risk map (probability–impact matrix). Again, note the four zones with different colors.



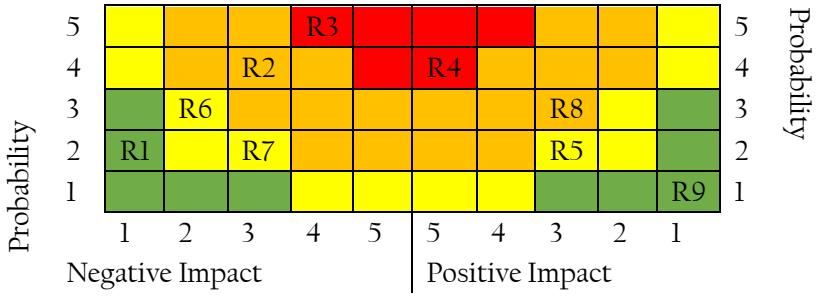
- You're free to define your risk scale. For instance, if you have a five-level scale, then you should have five colors on your risk map (probability–impact matrix).

♦ **How to do a risk map?**

- For your nine risks, you need to discuss their probability and impact ratings given your definitions of probability and impact. You should provide some justifications for why each risk has the given ratings. Once you have determined the ratings, you can calculate each risk's risk score (probability rating*impact rating). So, given my definitions above, I may have something like this:

Risks	Types of Risk	Probability Rating	Impact Rating	Risk Score
R1	Threat	2	1	2
R2	Threat	4	3	12
R3	Threat	5	4	20
R4	Opportunity	4	5	20
R5	Opportunity	2	3	6
R6	Threat	3	2	6
R7	Threat	2	3	6
R8	Opportunity	3	3	9
R9	Opportunity	1	1	1

- Given the risk scores and the risk scale shown above, I'll have a risk map like this:



- So, each of my risks is plotted on the map. For instance, R6 is a threat with a risk score of 6 (impact rating of 2 and probability rating of 3); R4 is an opportunity with a risk score of 20 (impact rating of 5 and probability rating of 4).
- There are many different ways to do risk maps. You do not necessarily have to use the exact format shown above.

A Holistic Learning-Model For Continuous Improvement In Risk Management Education

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ABSTRACT

Course design and follow-up influence learning quality in risk management education and are activities that should be evaluated on a regular basis. However, which factors these activities should be planned according to or evaluated against is not obvious. Literature on learning emphasises several aspects of relevance to the factors, including constructive alignment between the learning objectives, activities and assessment; the theoretical foundation; student engagement; feedback; and the frame conditions, such as time, competence, localities and equipment. In this paper, these aspects are seen in relation to each other and merged into a holistic model for learning, motivated by emergency response planning and the principle of continuous improvement. The model illustrates different factors that affect learning and can be used to describe, analyse and evaluate learning in higher education. To exemplify the model, it is used to evaluate questionnaires and report templates for the students' evaluation of teaching and learning and, further, to evaluate the course design and teaching work on courses in a master's programme in risk management and societal safety at a Norwegian university.

Keywords: risk management education; course design; formative feedback; learning model; reflection, student engagement.

INTRODUCTION

Risk management education is characterised by topical focuses on value creation, vulnerability, protection and decision-making under uncertainty, and should in some way capture needs in industry and society. Challenges related to company insurance practice are an integral part of this picture (Andreeva, 2021; Poradova & Kollar, 2020). As such, risk management students are typically exposed to a variety of theoretical and practical challenges linked to a set of learning objectives, where course design is an important variable. For this design, the courses should have a structure allowing students to achieve the relevant skill, knowledge and competence goals. The students themselves have a role in providing feedback related to course design and teaching quality.

Evaluation of course design and follow-up activities is important for learning quality for education in general but perhaps even more so for risk management education, with its multitude of applications. A key issue in this regard is which factors the teaching work and course design should be planned according to and evaluated against. To ensure high quality, evaluation of the design and the associated teaching and learning activities is essential. Students typically evaluate their courses on the basis of their experience, and their satisfaction relates particularly to the teaching and course organisation (Centoni & Maruotti, 2021), with course grades being positively correlated with scores on course evaluation instruments (Wang & Williamson, 2022).

Evaluation of learning in risk management education is a highly challenging task, which could be claimed to be 'imperfect'. Regarding the use of evaluation questionnaires, Nielsen and Kreiner (2017) argue that evaluations rarely disclose problems that a conscientious teacher does not already know about and, as such, provide a poor basis for course development. White et al. (2022) add to that, by showing that measurement and analysis choices used by classroom observation systems do not fully align with the conceptual understandings of teaching upon which observation systems are based. Moreover, based on a systematic literature review, McFadden and Williams (2020) conclude that there is a lack of knowledge about teachers' evaluative capabilities and how they employ these to understand the effectiveness of their teaching and learning programmes. In the literature reviewed, there was almost no focus on specific evaluation skills for teachers and no evidence of an explicit focus on the development of evaluative skills and attitudes in teacher education (McFadden & Williams, 2020). Similarly, in another literature review, Lohman (2021) found that basic principles of evaluating teachers' employee performance, principles that are well-established in human resource literature, are non-existent in ongoing debates on student evaluations of teaching.

To ensure learning quality, Gynnild (2007) emphasises the importance of a quality system that gains insights into the mechanisms that hinder and promote intended learning. This is supported by Wang and Williamson (2022), who propose the following recommendations to provide a more objective evaluation of teaching quality through course evaluation instruments: "quality design of the instrument, an attention to qualitative items, university level internal analyses, a portfolio approach to instructor evaluation, and increased efforts to tease out the nature of the relationship in future research" (p. 316).

In this article, we propose a model for describing, analysing and evaluating learning in higher education, which is based on factors important for learning. Scholars (e.g., Beckett & Hager, 2002; Hager, 2011; Sfard, 1998) differentiate between two ways of understanding learning related to professional practice, work and education. The 'individual cognitive approach' focuses on individuals as learners, where learning is understood as the acquisition of information and experiences (Ormrod, 2008; Bandura, 1977). 'Cognitive' here refers to mental processes: "the perception, encoding, storage, transformation, and retrieval of information — within individual minds" (Danish & Gresalfi, 2018). The individual's mental processes are regarded as central when this is transformed into knowledge, thus making reflection a crucial activity (see, e.g., Boud et al., 2006; Moon, 1999; Ormrod, 2008). The 'socio-cultural approach' to learning shifts the focus to social relations. Weick (1995) sees the mental processing of collective-social experiences and interactions as key to sensemaking. It is about how the environment influences perception. Attention thus shifts from the processing of information and the modifying of cognitive structures to the processes of participation and interaction that provide and sustain the proper context for learning (Gherardi et al., 1998). Hence, learning is situated in and occurs through processes of participation and interaction in educational or work-related activities, which makes contextual factors, interpersonal relationships, social climate and cultural artefacts decisive for learning to occur (see e.g., Billett, 2010; Eraut, 2004; 2007; Lave and Wenger, 1991; Wenger, 1998).

Some argue, however, that the two approaches complement each other and are both needed to fully explain individual learning. Illeris (2007; 2011), for example, argues that learning requires that both external interaction between the individual and the social, cultural and material environment and inner psychological processes within the individual take place. Emergency response organisations are a particular example where such a complementary perspective is adopted. These are organisations where learning is given a high level of attention, as the work of emergency response personnel is often dangerous and unpredictable, with lives at risk (Taber et al., 2008). Sommer (2015) has studied learning in these organisations, showing that both socio-cultural and individual aspects need to be considered to fully understand and explain how individuals develop competence. Adding to this, Sommer et al. (2013) have formulated a model for describing, analysing and planning learning, where the focus is on how individuals learn through a combined approach to learning in emergency response work. Bjørnsen et al. (2022) have assessed the model empirically with data from a national survey among Norwegian fire and rescue personnel, examining the factorial structure of the model and describing the direct and indirect effects between its

components. Their results confirm the theoretical model and indicate that the outcome of learning is influenced by the model's components.

We argue that the complementary perspective and model capturing both a socio-cultural and an individual aspect for learning and continuous improvement could also be relevant for other organisations and might add value to planning in higher education. It thus represents a tool worthy of investigation. In this paper, the model is reformulated and adapted specifically to learning in risk management education at master's level.

For a holistic perspective, we also use our model as a basis for the assessment of different evaluation questionnaires and report templates used to evaluate teaching and learning. The focus is on the university internal quality system for education, in addition to the Norwegian national student survey (Studiebarometeret).

DEXCRIPTION OF A MODEL FOR LEARNING IN EMERGENCY RESPONSE WORK

Sommer et al. (2013) link learning to decision-making, where the socio-cultural and individual aspects influence how individuals learn and respond to accidents and emergencies (see Figure 1).

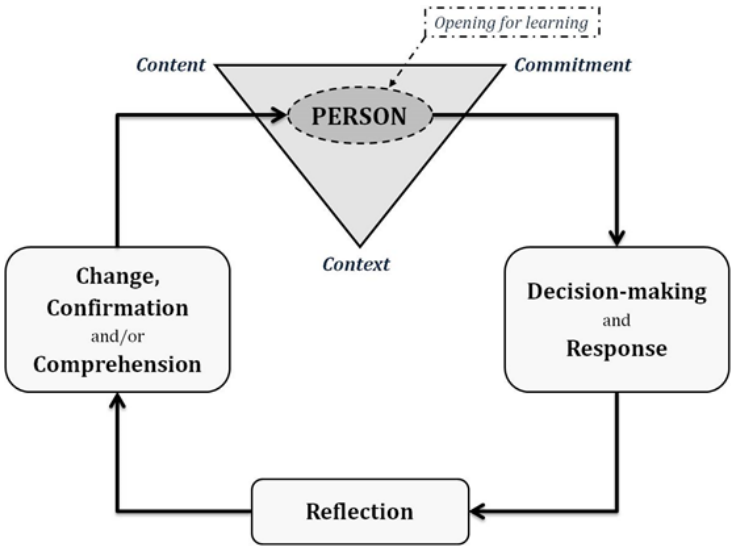

Figure 1. Model for learning in emergency response work (Sommer et al., 2013).

In the model, the person is someone entering a learning process. For this person to learn, there must be a knowledge or skill content to acquire. This content could be specific skills, a certain kind of behaviour, how to understand and interpret situations or how to operate technology and tools. The context is the learning environment in which this acquisition takes place. According to the socio-cultural approach, participation and interaction between colleagues are vital for learning. Environmental factors and contextual features are thus highlighted. Finally, individuals' commitment (i.e., involvement in learning activities) also plays a role. With reference to the individual cognitive approach, both mental and physical activities are of relevance.

The decision-making and response element in the model refers to the person's performance in a real emergency situation or in a training situation. The response reflects the decisions made, which will lead to the outcome of the situation (see, e.g., Flin et al., 2008; Rake and Njå, 2009; Salas et al., 2010).

Reflection is another element of the model. According to Kolb (2015) and Schön (1983), reflection constitutes the essence of learning in an individual cognitive approach. For individuals to learn from emergency

response situations, they need to reflect on their performance (i.e., their decision-making and response) and the usefulness of their skills and knowledge.

The reflection could result in, for example, change in behaviour, confirmation of existing knowledge or new comprehension of knowledge. The result is captured in the model by the element called 'change confirmation and/or comprehension'. This refers to ways to categorise the outcome of learning (Braut and Njå, 2010).

For a more detailed description of the model and its theoretical foundations, see Sommer et al. (2013).

A MODEL FOR LEARNING IN HIGHER EDUCATION. A REFOMULATED VERSION OF THE MODEL FOR LEARNING IN EMERGENCY RESPONSE WORK

For learning, it matters what the students themselves do to learn. Biggs (1999) sees this in relation to a deep approach to learning and opportunities for reflection. To achieve this, learning objectives, teaching and learning activities and assessment must be aligned (ibid.), with all three elements motivating reflection. The alignment is illustrated in Figure 2.

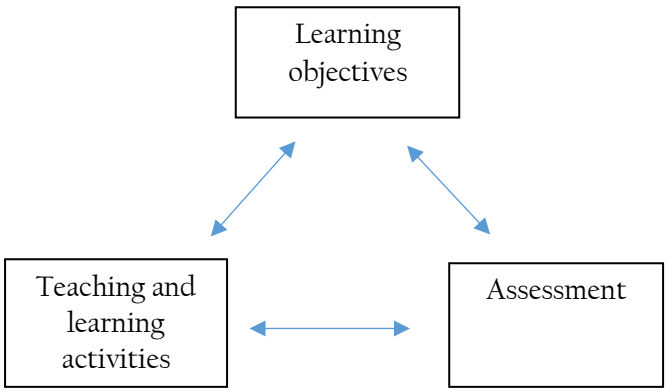

Figure 2. The link between curriculum objectives, teaching/learning activities and assessment tasks in a course design (Biggs, 1999).

In course design, the learning objectives indicate knowledge and skills that students should acquire through the course. The learning processes can then be developed accordingly, so that students are able to achieve the intended learning outcomes (Biggs, 1999; Gynnild, 2010). Gynnild describes this as backwards planning of courses (see Figure 3). The word 'backwards' is used, as the planning starts with the desired results and then identifies evidence necessary to determine whether the results have been achieved. With the results and assessments clearly specified, the lecturer can determine the necessary knowledge and skill and, only then, the teaching needed to equip students to perform (see Wiggins & McTighe, 2005).

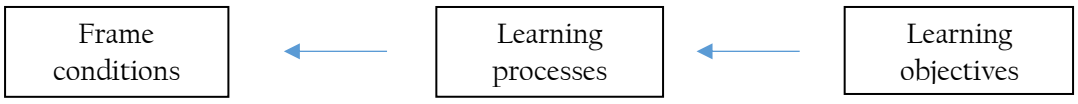

Figure 3. Backwards planning of course design and activities (Gynnild, 2010).

With reference to Figures 2 and 3, and by shifting focus from emergency response workers to students, a model for learning in a university teaching context can be established. The reformulated model in Figure 4 points, instead, to relevant learning factors. In Sections 3.1 to 3.6, we describe the elements of the model.

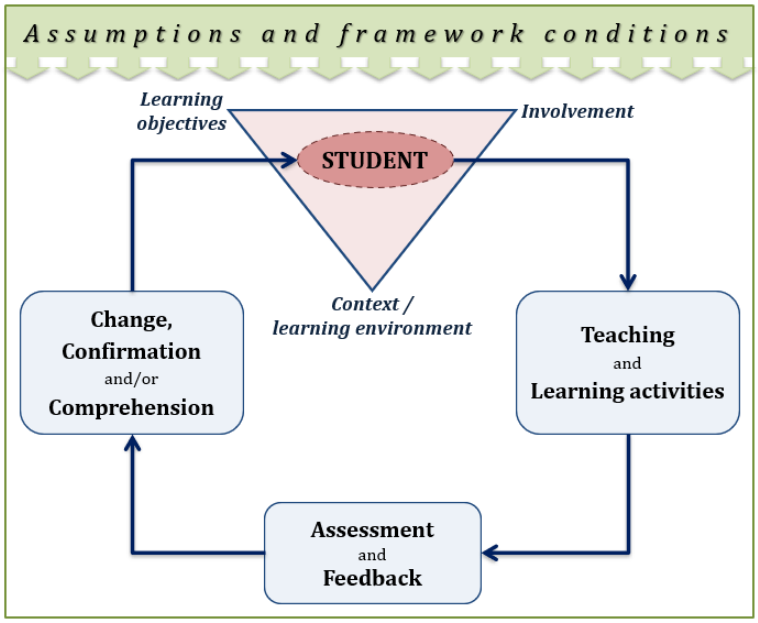

Figure 4. Learning in higher education.

Student and learning objectives, involvement, context/learning environment

The focus is on what the students themselves do to learn. From a constructivist view, learning occurs as the acquisition of knowledge and skills through experience and information acquired (Jonassen, 1992). What the student has to learn constitutes the intended content of the student's learning and is expressed through the learning objectives. To achieve good learning, the intended content and learning objectives must be geared towards a deep approach to learning, i.e., a focus on understanding rather than memorising and acquiring facts and procedures (Biggs, 1999; Gibbs, 1992). Here, however, a distinction can be made, depending on the study level and learning objectives. Case and Marshall (2004) describe the learning approaches, 'procedural deep' and 'procedural surface', as two "intermediate approaches" to the classic depth and surface approaches to learning. For the procedural deep approach, the goal is to achieve a deeper understanding of the content, for example by relating different formulas/procedures to each other and through practical exercises in problem-solving, while, for the conceptual deep approach, the goal is, rather, to achieve a deeper understanding of phenomena and concepts.

Ownership and personal involvement are pointed to as important for in-depth understanding. However, the involvement of students in a teaching situation does not happen automatically; a context facilitating and promoting involvement is needed. According to the socio-cultural approach, learning is something happening in "collaboration with others" (Hernandez et al., 2015). It is seen as a natural human trait and something that is situated and happens through participatory processes (Lave & Wenger, 1991). Learning comes from observation of others (Bandura, 1977) but also from dialogue and interaction with more competent people (Vygotsky 1978). The learning environment in the teaching situation is something that both Hernandez et al. (2015) and Bain (2004) emphasise as important for students' learning.

The three elements, i) learning objectives, ii) student involvement and iii) context or learning environment, influence students' ability to learn and can be seen as essential for learning. However, it is important to understand

what influences these elements. When designing the teaching plan, for example, Gibbs (1992) claims that aspects such as what activates the students and motivates them to learn should be considered.

Teaching and learning activities

For students to successfully achieve the intended learning outcomes, appropriate teaching and learning activities should be applied, and these should promote the development of in-depth understanding (Biggs, 1999). The activities obviously have a strong influence on the learning environment. A variety of teaching- and learning activities are relevant for this: from traditional lectures and self-study/problem solving, to seminars, group work and project assignments. However, the full learning environment might not be visible to the lecturers. As noted in Symons (2021), with reference to the 'iceberg of engagement' analogy, 'beneath the surface' "considerable engagement and learning can be taking place". We refer to Schmidt et al. (2017) for a discussion of different activities in relation to student engagement.

Involvement is already mentioned as crucial for learning. This points also to student engagement, as there is a belief that learning improves when students are fully involved in their learning (Deslauriers et al., 2019). Problem-based learning, case studies and project work are highlighted in this context as particularly suitable (Kolmos, 1996). These are activities promoting ownership and collaboration, aspects for example pointed to in the development of the LEAP framework for student learning development (McIntosh & Barden, 2019). It indicates, as Bain (2004) argues, that it is not necessarily the activity type that is crucial but how the students are addressed, for example when using questions (problems) in teaching:

1) questions are asked that students find interesting and challenging and, not least, relevant to the practice of the profession after graduation;
2) students are helped to understand the importance of the questions;
3) students must "think for themselves" through, e.g., comparing, applying, evaluating, analysing and summarising, not just listening, reading and remembering;
4) students receive help with answering the questions; and
5) after answering the questions, students should be provided with new questions which take them a step further.

Assessment and feedback

Assessment is often a part of the course design. Biggs (1999) claims that assessment should be performed in accordance with both the learning objectives and the teaching and learning activities, to ensure good learning. Assessment is of special importance for both students and educational institutions, as it provides information about the students' academic achievements and qualifications after completing the course (Sadler, 2009; 2010). In addition, students usually prioritise activities in which they are evaluated and awarded, which means that they are most involved in the assessment activities and therefore learn most from working with these activities (see Gibbs, 1999; Hargreaves, 1997; Alhija, 2017; Kickert et al., 2022). Students' perceptions of assessment quality are also related to their learning approaches and learning outcomes (Gerritsen-van Leeuwenkamp et al., 2019); perceptions of the effects of assessment on learning are positively related to the deep learning approach and the strategic learning approach and negatively related to the surface approach, and perceptions of the conditions of assessment are positively related to the students' learning outcome of the assessments. Furthermore, we refer to Schellekens et al. (2021) for a review of the association between assessment and learning.

For assessments to truly represent the student's academic achievement, Sadler (2009) recommends that academic standards are used as the basis for evaluating students' performance (in contrast with a norm-based assessment, where student performance is assessed against the performance of, e.g., a group of students). The standards used for assessment should be designed specifically according to the content of the course. Bloxham (2012) claims they are a fundamental basis for universities' credibility. We refer to Bloxham (ibid.) for a discussion around the use of academic standards.

Ideally, assessments should provide students with feedback on their performance and should then be a tool for improving their performance (Carless, 2015; Sadler, 2010). But, as Sadler (ibid.) argues, for this to contribute to improvement, feedback should be formative, regardless of when given. Specific, concrete and organised feedback allows students to improve their performance. This is supported by Granberg et al. (2021), who found that formative assessment practice has a significant effect on both students' motivational beliefs and behaviours involved in the self-regulation of learning. Evans (2013) also adds socio-cultural aspects as important in this regard.

Change, confirmation and/or comprehension

Assessments and feedback might lead to change, confirmation and/or comprehension related to knowledge or skills. Traditionally, learning as a concept refers to something that leads to changed behaviour or cognition (see, e.g., Illeris, 2007; Ormrod, 2008), which could be the case if a student receives constructive feedback and makes changes before the assignment is submitted. But, in addition to changes, learning can also be related to confirmation and comprehension of knowledge or skills. If a student receives feedback that, say, calculations are correct, there is no need for change. Nevertheless, such feedback can still contribute to learning, since the student receives feedback on what is correct and, implicitly, that the same approach for calculation can be adopted for similar problems in the future. In other words, confirmation is a form of positive reinforcement, which is important to the individual cognitive approach to learning (see Ormrod, 2008). Comprehension is a step further. For comprehension, the student should then have deeper understanding of the content studied.

Assumptions and framework conditions

Assumptions and framework conditions refer to external factors normally outside the control of students and lecturers but which influence the teaching and learning frame. For example, at the institution, there might be a certain pedagogic design that the lecturers must adopt. Related to workload, the students might also attend other courses with activities influencing the time they may spend on the course. Location is also of relevance. For example, the lecture rooms might have limitations and not be suited to the pedagogic design. Another example is the changes triggered by the COVID-19 pandemic situation in 2020, where classrooms were closed and teaching and examinations became digital. All these factors influence the way a course is presented to students and the way the students work, and they should be considered when assessing students' learning.

The learning model as a continuous process

The model focuses on various factors influencing student learning on a course. It must be emphasised that, in the model, learning is seen as a continuous process, from the start of the course until the result of the final examination is received. Instead of a traditional one final examination, on which everything stands and falls, a type of portfolio-based assessment could be considered. Tolosa Bailén and García Bernabeu (2012) consider continuous assessment, with a portfolio of assessments, as an effective alternative to the traditional ways. In addition, students underway on the course could seek and receive constructive feedback from fellow students and the lecturers, beyond the formal assessments, adding to the learning.

ANALYSIS OF EVALUATION QUESTIONNAIRES AND REPORT TEMPLATES USED TO EVALUATE TEACHING AND LEARNING

To evaluate teaching and learning, the university uses its internal quality system for education, in addition to results from the Norwegian national student survey. In this section, we analyse the evaluation questionnaires and report templates used, to see which elements of the model for learning in higher education (see figure 4) are covered and have information collected about them.

Table 1 is used as starting point for our analysis. In the first column, we list all the questions in each of the evaluation forms or surveys analysed. In the next columns, we include all the dimensions from the model of learning

in higher education. Nine dimensions are included: student; learning goals; context; involvement; teaching and learning activities; assessment; feedback; change, confirmation and/or understanding; and assumptions and framework conditions. For each question, we see which elements are covered and have information collected about them. For each question, we mark "x" for those elements of the model for learning in higher education that are covered and information collected about. The table was first filled in by all the authors of this paper. For those questions with different conclusions about the dimensions covered, consensus was reached after discussions. Note that the categorisation of each question is not absolute, and some questions may also fit into several categories. In the second row of the table, we summarise the number of questions covering each of the various elements in the model. We then obtain an overview of which dimensions are covered by many, few or no questions in the various surveys. All the evaluation questionnaires and report templates used in this analysis are from 2022. We have omitted all the COVID-related questions, as these cover an extraordinary situation. The questions in the different surveys are usually modified every year, but the differences from year to year are usually relatively small.

Table 1. Basis for evaluation of which elements in the model for learning in higher education are covered by different student evaluation questionnaires.

Student Survey	Student	Learning objectives	Context	Involvement	Teaching and learning activities	Assessment	Feedback	Change, confirmation and/or comprehension	Assumptions and framework conditions
Total number of questions	#	#	#	#	#	#	#	#	#
Category X									
Question 1									
Question 2									
...									
Category Y									
Question 1									
Question 2									
...									

The university's internal quality system for education

The internal quality system is a three-tier quality system for all studies at Bachelor's, Master's, and PhD levels. The division comprises quality in courses, study programmes and study portfolios. Reports constitute important documentation, and the quality work at the study programme level and the study portfolio level mainly builds on information collected at the course level. Information at the course level is collected through dialogues with students and a digital course evaluation and then summarised in a course report.

Dialogues with students, named "Early dialogue", must take place at an early stage during the semester, each time a course is taught. These dialogues shall be conducted between the course coordinators and the students, with the aim of receiving feedback from students in respect of changes and adjustments to be made during the course for the current semester. The course coordinators and student representatives write a brief summary of the discussions that will form part of the basis for the course reports. The question in the template for the early dialogue is shown in Table 2, together with all nine elements of the model for learning in higher education.

Table 2. Elements in the model for learning in higher education covered by the early dialogue questionnaire.

Early dialogue	Student	Learning objectives	Context	Involvement	Teaching and learning activities	Assessment	Feedback	Change, confirmation and/or comprehension	Assumptions and framework conditions
Total number of questions	0	1	0	0	0	0	1	2	0
Lectures: How do you find the lectures?									
Information about course and syllabus: Have you received the necessary information about the course and is the syllabus clearly defined?		x						x	
Canvas: How does the use of Canvas work?								x	
Feedback: Is the feedback you receive on your work sufficient?							x		
Other topics: Other conditions that work well or that should be addressed?									

Digital course evaluations are a standardised student evaluation of courses that shall be carried out at the end of the semester. The purpose is to collect anonymously the students' experiences of the course, and the results are presented in a report automatically generated from the survey. The questions used in the digital course evaluation are shown in Table 3, together with all the elements of the model for learning in higher education.

Table 3. Elements in the model for learning in higher education covered by the digital course evaluation questionnaire.

Digital course evaluation	Student	Learning objectives	Context	Involvement	Teaching and learning activities	Assessment	Feedback	Change, confirmation and/or comprehension	Assumptions and framework conditions
Total number of questions	4	0	1	0	2	0	1	0	2
Own involvement									
Approximately how many hours per week (on average throughout this semester) have you spent on this course (self-study, lectures, seminars etc.)?	x								
How satisfied are you with your own effort in this course?	x								
Have you participated in any organized learning/teaching activities in this course (lectures, seminars etc.)?	x								
To what degree did you achieve the learning outcomes for the course?	x								
Teaching and learning									
Does the teaching in this course convey the curriculum in an understandable way?					x				
Do the organized learning/teaching activities contribute to your learning?					x				
Was the use of digital tools appropriate to support your learning? (This does not refer to streaming/recording of lectures)									x
Communication									
How satisfied are you with the information you have received about this course (on Canvas, etc.)?									X
How satisfied are you with the feedback and guidance in this course?							x		
Learning environment									
How satisfied are you with the academic and social environment among the students in this course?			x						
Overall satisfaction									
How satisfied are you, overall, with this course?									

Course reports must be written by the course coordinator once a course has been completed. The course report shall express the course coordinator's own assessment of what is working well and what should be changed in the course, based on dialogues with the students early in the semester and results from the digital course evaluation at the end of the semester, in addition to discussions with other lecturers if they have taken part in the course. The questions to be answered and elements to be addressed in the course report are shown in Table 4, together with all the elements of the model for learning in higher education.

Table 4. Elements in the model for learning in higher education covered by the questionnaire in the course report.

Course report	Student	Learning objectives	Context	Involvement	Teaching and learning activities	Assessment	Feedback	Change, confirmation and/or comprehension	Assumptions and framework conditions
Total number of questions	0	0	0	0	3	1	2	0	0
Evaluation form									
How was the course evaluated by the students? (Discussions with students, Discussions with student representative, Standardised student evaluations, Additional information)									
Teaching method									
What tuition and learning methods have been practised during the course this semester?					x				
Coursework									
What compulsory tuition activities have been used during the course?					x				
Form of assessment									
What forms of assessment have been used during the course?									
Student guidance									
Please specify what forms of feedback/supervision the students have received during the course					(x)		x		
Feedback									
Please write a short summary of student feedback. Relevant topics here may include: Were any suggestions made about improvements/changes during the early discussions? Was anything done about it, and if so, what? What is the feedback in the standardised student evaluations (UiS Insight Education)? Is there anything in this feedback that will result in changes next year? According to the students, what worked well and what didn't work so well?							x		
Assessment									
Assessment related to the course. Different questions on assessment of learning outcome descriptions, form of learning, context, teaching materials, etc.						x			

In Table 5, we show the total number of questions covering each dimension in the model for learning in higher education. From this summary, we see that many of the dimensions are only covered to a small extent. The involvement is not covered in either the early dialogue, digital course evaluation or in the course report. This means that limited help and limited information are provided, which means that it is up to each course coordinator and lecturer to collect any additional information, to make an evaluation of the learning on each course.

Table 5. The total number of questions in the different forms used by UiS (part of the internal quality system for education), covering each of the elements in the model for learning in higher education.

	Student	Learning objectives	Context	Involvement	Teaching and learning activities	Assessment	Feedback	Change, confirmation and/or comprehension	Assumptions and framework conditions
Early dialogue Total number of questions	0	1	0	0	0	0	1	2	0
Digital course evaluation Total number of questions	4	0	1	0	2	0	1	0	2
Course report Total number of questions	0	0	0	0	3	1	2	0	0
Early dialogue + Digital course evaluation + Course report Total number of questions	4	1	1	0	5	1	4	2	2

Norwegian national student survey (Studiebarometeret)

The Norwegian national student survey is a survey sent to more than 70,000 students in their 2nd and 5th academic year, each autumn. The survey asks for the students' perceptions of educational quality in their study programmes. The purpose of the survey is to strengthen the quality of work in higher education and give useful information about educational quality. The portal for the survey, where new results are published in February each year, provides information for applicants, students, institutions and members of staff and others with an interest in higher education. The survey is initiated by the Norwegian Ministry of Education and Research and conducted by the Norwegian Agency for Quality Assurance in Education (NOKUT).

The questions to be answered and elements to be addressed in the study are shown in Table 6, together with all the elements of the model for learning in higher education.

Table 6. Elements in the model for learning in higher education covered by the Norwegian national study survey.

Student Survey (Studiebarometeret)	Student	Learning objectives	Context	Involvement	Teaching and learning activities	Assessment	Feedback	Change, confirmation and/or comprehension	Assumptions and framework conditions
Total number of questions	41	15	10	5	7	4	17	0	39
Teaching									
To what extent do you agree with the following statements?									
The academic staff make lectures and seminars engaging			x						
The academic staff convey the curriculum in an easy-to-understand manner			x						
The teaching covers central parts of the curriculum well		x							
The teaching is organised so as to facilitate active student participation				x					
Extent of feedback and academic counselling									
This far in your studies, how often have you:									
Received feedback from academic staff on your written work before final submission							x		
Received feedback from academic staff after final submission of your work							x		
Received feedback from academic staff on non-written work							x		
Received feedback from other students on written or non-written work							x		

Discussed academic issues with academic staff							x		
Discussed your academic progression/results with academic staff							x		
Feedback and academic counselling									
How satisfied are you with:									
The number of times you have received feedback from academic staff on your work							x		
The academic staff's ability to give constructive feedback on your work		(x)	(x)	(x)			x		
Your fellow students' ability to give constructive feedback on your work		(x)	(x)	(x)			x		
Academic supervision and discussions with academic staff							x		
Academic and social environment									
How satisfied are you with:									
The social environment among the students in the programme			x						
The academic environment among the students in the programme			x						
The relationship between the students and the academic staff in the programme			x						
The study environment and infrastructure									
How satisfied are you with:									
Rooms for teaching and general studies									x
Equipment and tools used in teaching									x
The library and library services									x
ICT tools and services (e.g., teaching platforms, software and PC availability)									x
Organisation of the study programme									
How satisfied are you with:									
The availability of information about your study programme									x
The quality of information about your study programme									x
The administrative organisation of your study programme (e.g., teaching schedules, study plans)								x	
The extent to which courses in your study programme are academically connected and well-integrated							x		
Student assessment									
To what extent do you find that examinations and other assignments so far have:									
Concerned central parts of the curriculum						x	x		
Required comprehension and reasoning skills						x	x		
Had clear evaluation criteria						x	x		
Contributed to your academic development						x	x		
Student participation									
To what extent do you experience that students have the opportunity to provide feedback on the content and structure of the study programme?			x				x		x

The study programme's ability to inspire you									
To what extent do you find that the programme:									
Is stimulating	x								x
Is academically challenging	x								x
Contributes to motivation to work on your studies	x								x
Your learning outcomes									
How satisfied are you with your own learning outcomes so far, concerning:									
Theoretical knowledge	x								
Knowledge of scientific work methods and research	x								
Experience with research and development work	x								
Discipline- or profession-specific skills	x								
Critical thinking and reflection	x								
Cooperative skills	x								
Oral communication skills	x								
Written communication skills	x								
Innovative thinking	x								
Ability to work independently	x								
Motivation									
To what extent do you agree with the following statements:									
I am motivated to work on my studies	x								
I participate in the organised learning activities that are offered	x				x				
I show up well prepared for organised learning activities	x				x				
I consider myself a hard-working student	x				x				
Expectations									
To what extent do you agree with the following statements:									
The academic staff set clear expectations for me as a student	x								x
The academic staff expect me to come prepared to organised learning activities	x								x
The academic staff expect me to participate actively in organised learning activities	x								x
The academic staff have high academic expectations for me	x								x
Use of digital tools									
By digital tools we are referring to, for instance: Digital teaching platforms (Canvas, Blackboard, It' learning, etc.), Online teaching software (Zoom, Teams, etc.), Software (Excel, Stata, MatLab, Python, Photoshop, etc.), Social media (Forum, Facebook, etc.), Web-based tools and media (YouTube, Kahoot, Google Drive, etc.) and Video recordings, streaming, podcasts, etc. To what extent do you experience the following:									
Digital tools are used in such a way that I am actively involved in class				x					x
The academic staff have the necessary knowledge and								x	

skills to use digital tools in their teaching									
I am trained in using digital tools/programmes that are relevant to my subject field		(x)	x						x
The use of digital learning platforms works well in my study programme									x
Overall satisfaction									
To what extent do you agree with the following statements:									
I am attending the study programme of my first choice									
I am, overall, satisfied with the programme I am currently attending									
Time spent on academic activities									
Indicate how many hours per week, on average in your study programme this far (not including holidays), you spend on:									
Learning activities organised by the institution (including all teaching and counselling sessions, plus supervised professional training if relevant)	x								
Independent study (assigned readings, assignments, group work with other students, etc.)	x								
Time spent on a paid job									
Indicate how many hours per week, on average in your current study programme (not including holidays), you spend on paid work.	x								
Supervised professional training (work placement)									
Supervised professional training (also known as work placement) is usually conducted at an external workplace, for instance a hospital, school or company (external supervised professional training). Supervised professional training may also be conducted internally at the university college / university, for instance at internal clinics at the institution. The training may be mandatory or voluntary.									
Have you had supervised professional training organised as part of your study programme? (Yes/No)		(x)	x						x
How satisfied are you with:									
The information you received ahead of the supervised professional training		(x)							x
How the university / university college prepared you for supervised professional training		(x)		(x)					x
How well the supervised professional training fit into the programme's study plan		(x)			(x)				x
The academic supervision you received during your supervised professional training					(x)		(x)		x
What you learnt from your training period	(x)	(x)							x
The extent to which the tasks you were given during		(x)							x

your training period were relevant to your studies									
How the study programme facilitates reflection around your experiences from professional training							(x)		x
Working life relevance									
Here we want you to consider the information and the opportunities that are provided by both your study programme and other parts of the institution, such as career centres and student councils. To what extent do you experience the following:									
I receive useful information about how my skills and knowledge can be used in the labour market		(x)							x
I receive useful information about which occupations/fields are relevant for me		(x)							x
I receive training in how to convey my skills and knowledge to potential employers		(x)							x
Representatives from the labour market contribute to teaching (e.g., as guest lecturers / instructors)		(x)							x
There are possibilities for cooperating with representatives from the labour market on projects / coursework		(x)							x
Learning outcome descriptors - background questions									
Select the statement that best describes your situation:									
I was familiar with the learning outcome descriptors for the programme I am currently attending before applying	x								x
I became familiar with the learning outcome descriptors for the programme I am currently attending after being accepted	x								x
I am not familiar with the learning outcome descriptors for the programme I am currently attending	x								x
Have you completed, or are you planning to undergo, a...									
transfer to a different programme and/or higher education institution (HEI) in Norway?	x								x
foreign exchange programme?	x								x
None of the above	x								x
Learning outcome descriptors									
To what extent do you agree with the following statements regarding learning outcome descriptors?									
The learning outcome descriptors are easy to understand	x								
The learning outcome descriptors were a key factor	x								

in my choice of higher education institution									
The working life relevance of the learning outcome descriptors was a key factor in my choice of study programme	x								
The learning outcome descriptors for individual courses are clearly tied to the learning outcome descriptors for the study programme as a whole	x								
I make use of the learning outcome descriptors when choosing courses / my major	x								
I make use of the learning outcome descriptors when preparing for exams	x								
The learning outcome descriptors correspond to what I've learned in the courses I have already completed	x								
The learning outcome descriptors are important when transferring to other study programmes / higher education institutions	x								
The learning outcome descriptors are useful when planning (foreign exchange) stays abroad	x								
The learning outcome descriptors are useful when applying for specific recognition of foreign exchange programmes	x								
Teaching and learning methods - usage									
To what degree are these teaching and learning methods used in your programme?					x				
Teaching and learning methods - contribution									
To what degree do these teaching and learning methods contribute to your learning?					x				

Table 7 shows the total number of questions in the Norwegian national study survey covering each dimension in the model for learning in higher education. From this summary, we see that many of the dimensions are well covered in relation to the learning model. It provides some answers regarding how many participate in learning activities, whether the teaching covers the curriculum well and whether students are satisfied with, e.g., the learning environment and feedback given on student work, as well as their satisfaction related to their learning outcomes. However, with a focus on students' satisfaction, it does not necessarily provide accurate information to the course coordinator and lecturer about the actual learning in the subject.

Table 7. The total number of questions in the Norwegian national study survey covering each of the elements in the model for learning in higher education.

Student Survey (Studiebarometeret)	Student	Learning objectives	Context	Involvement	Teaching and learning activities	Assessment	Feedback	Change, confirmation and/or comprehension	Assumptions and framework conditions
Total number of questions	41	15	10	5	7	4	17	0	39

ANALYSIS OF TEACHING AND LEARNING IN A MASTER'S PROGRAMME IN RISK AND SAFETY MANAGEMENT

In this section, we analyse the teaching and learning in the master's programme in risk and safety management, to see which elements of the model for learning in higher education are covered and have information collected about them. In this way, we see how the model can also be used to evaluate study degree programmes. As a basis for discussion, some rudimentary information is given for the master's programme in focus. The programme is so-called experience-based, meaning that prior work experience is required for admission, offered at a university in Norway and has a 90-credit workload. It is flexible, in the sense that students may choose to only take courses and do not have to sign up for the full programme.

Activities are set up such that students can combine studying and work. To allow for this, teaching and supervision are organised into five or six full days for a 10-credit course (spread over three sessions). For the remainder of this section, we will present the content of the courses, 'Risk management' and 'Risk analysis', being the two courses discussed in Section 6. The two courses are structured similarly and typically have 20-30 students each.

The courses are structured as a combination of lectures and project work, with the project work intended to cover 25% of the student workload on the course. There is a total of three full days of lectures on the course, covering basic theory. During the lectures, dialogue and student involvement are emphasised. Hence, the students are continuously invited to reflect and share their own experiences on the topics addressed.

Our reflections upon which elements in the model are covered in the master's programme in risk and safety management are given below.

Learning objectives, involvement, context/learning environment

Learning objectives on these courses are relevant knowledge and skills in risk management and analysis. A main principle is that the courses should build on the knowledge and understanding acquired by the students through their work experience.

Teaching and learning activities

The courses start with two days of lectures (session one), in which basic theory is presented. During these days, the students form groups and try to formulate a problem for their project work (as the core is problem-based learning). At the end of each day, the groups spend time with the supervisors to establish a basis for the project work. The group continues working on this for around a month before the next session. Session two is a full day with supervision, in which the groups work together and receive supervision. Note that the groups might also ask for supervision/feedback outside the sessions. Afterwards, the groups have about one month before they must submit their report. This report is presented by the group to the supervisors, with only the group and the supervisors present. In addition, in this third session, there is also a full day with lectures. The oral examination is individual and takes place around three weeks after the third and final session.

Assessment and feedback

Supervision and feedback on the project work are given considerable attention. Several rounds of supervision are scheduled throughout the course, in addition to voluntary extra supervision for those groups who ask for it. The students also receive feedback on basic theory questions they might have. During supervision, the students receive feedback on the work they have conducted so far and on what can be improved. The emphasis is on helping students reach a deeper understanding, for example though supervisors asking questions to encourage critical thinking and reflection.

In the oral examination, students are asked questions to test their basic theory knowledge and deeper understanding. Students are evaluated based on a combination of written work and the oral examination, with the project work counting for 25%. In the final session, after their presentation of the project work, students receive oral feedback on the report and presentation. They are awarded a specific evaluation and grade for this work, given to the group as a whole.

Change, confirmation and/or comprehension

Through communication with the supervisors, who focus especially on giving feedback on what the students have got correct (i.e., confirmation) and what they need to improve (i.e., change), the groups acquire understanding of what works and how to address relevant problems within the discipline. They also learn from each other, share experience and contribute to a common product, as well as building on the theory acquired from lectures and the curriculum. The point is to have them apply theory in practice – to apply it, rather that summarise or repeat this in a report. This theory processing makes the students identify various benefits and challenges for themselves and places them into their own context and use, thus contributing to a deeper understanding (i.e., comprehension).

Assumptions and framework conditions

Students' learning related to the project work builds on the premise of motivated students and that they spend time on their studies. The motivation could obviously influence the group dynamics if someone is unwilling to contribute or expresses discomfort with the group. The situation is the same if someone is not able or willing to spend time on the work and acts as a passive member of the group. For these courses, the total workload is estimated at around 250 hours. It is assumed that the university has ensured enough resources to prepare and carry out lectures and to give the necessary supervision and feedback to the students.

Course evaluation

After each course, students receive a questionnaire, in which they can give their input for evaluation of the course. This is sent out electronically, and students can give their opinion on how satisfied they are, what they think is good/not-so-good and how the course could be improved. There is also dialogue with students during the course, to capture whether there are things to adjust along the way. As pointed out in Section 4, we have seen that there is little help in the different forms used, which is the basis for the university's internal quality system for education, when evaluating students' learning. They provide limited help and limited information, which means that it is up to each course coordinator and lecturer to collect any additional information in order to make an evaluation of the learning on each course.

DISCUSSION – USE OF THE LEARNING MODEL FOR ANALYSIS AND EVALUATION

The model pinpoints the basis for learning on courses and points to aspects that are important for evaluation and continuous student learning. As such, the model can be seen as a starting point for considerations around how the current design contributes to student learning. The model can be used to identify challenges and potentials for improved learning. In the discussion below, course-specific details are omitted, as our primary focus is on the learning aspects covered by the model.

Learning objective, involvement, context/learning environment

The potential for improved learning needs to be seen in relation to the achievement of learning objectives. The objectives influence course design and consequently influence the learning environment. Hence, objectives should be appropriate and regularly revised. The lecturer has a responsibility here, but it is important that other actors are also invited to give inputs to the revision work, for quality assurance.

Teaching and learning activities

For teaching and learning activities, the focus is on course design and how it works in practice. To be more specific on this, we refer to data collected during the autumn of 2019. A questionnaire was completed by 45 students from industry and public sector contexts about how different activities influenced their learning capabilities; see Table 8. The percentage shows how the students, if they were given full flexibility regarding the course, would like to distribute the time (250 hours) they spend on the course.

Table 8. Results, data collection 2019 (n=45): Student opinion on optimal distribution of course time

Activity	Avg. percentage of time
Attending lectures in classroom	24 %
Use of video lectures	10 %
Project work and reporting	14 %
Use of e-learning modules	9 %
Participating in discussions in the classroom	6 %
Participating in discussions outside the classroom	4 %
Reading literature (textbook/curriculum)	17 %
Preparing for exam	17 %
Sum	100 %

The distribution gives students' opinions on which activities are best for learning, i.e., how they best achieve the learning objectives. Obviously, there is some variation among students, as they typically have mixed experience regarding what works, besides having varying bases and ambitions for the course. This influences both what they want to achieve and whether they are willing to do what it takes to get there. Here, already at the beginning of the course, there could be a mismatch between the expectations of the lecturer and the students. For example, the project work plays a main role in the design of the course and counts for 25% of their final grade. However, from Table 8, it seems that this is not an activity valued highly by the students. Obviously, project work requires participation and involvement. Students trying to minimise their efforts would most likely have reduced learning benefits from learning activities such as project work. It also depends on how they perceive the quality of these activities on the course they have attended. For example, if they have been in a strong project group, this might make them more positive towards such an activity. Nevertheless, there could also be a gap between what is preferred by the student and how the lecturer concludes regarding what benefits learning, for example, when being asked for the benefits of project work, specifically, the students score this somewhat low. However, the lecturer might claim that this is not necessarily because of the benefits but because it is more motivating or convenient for the student to sit in a classroom listening to the lecturer than to have to work on solving a project in a group. For the lectures, as Bain (2014) claims, it matters greatly how the lectures are carried out – a lecture that raises interesting and relevant questions and then helps students to think and gain a deeper understanding will contribute to good learning. A key is to understand mechanisms and what works for the students.

Problem-based learning has a strong focus on student involvement, interactions between the students, ownership and responsibility (English & Kitsantas, 2013; Steinemann, 2003), with students being expected to take a more active role. But not all students might be ready or prefer to take such a role. Hence, the lecturers must pay attention and, if necessary, take action to ensure that students have equal opportunities and bases for learning, so that the learning objectives are achieved by the individual students and not just by the project groups. Particularly, if there are students with high ambitions, setting goals that are too high or too low could make them feel a sense of failure and thus unmotivated to complete tasks (Sternberg & Williams, 2002).

Further, students should interact with other students and lecturers and spend time reflecting on the experience acquired (see Kolb, 2015; Schön, 1983). In literature, the importance of the repetition of content previously lectured on is pointed to (Tafreschi & Thiemann, 2016). Repetition is a way to highlight key parts of

the curriculum and to strengthen the reflections. It is part of cognitive processing: to remember better, but also for better understanding, for example, by having the content presented from a different perspective or making the students present it in their own words. Biggs and Tang (2011) suggest that formative feedback can benefit students in this process.

Assessment and feedback

Both project work assessment and final examinations build on the premise that they will test the achievement of learning objectives. However, students may be motivated in different ways. The way in which they are motivated plays a role in students' interest in the feedback and in learning effectiveness (Cerasoli et al., 2014). Strongly focusing on scoring well in the examination constitutes an extrinsic motivation, and such students might not focus as much on learning according to the full scope of the course. Zaccone and Pedrini (2019) have analysed empirical data on the issue and conclude that intrinsic motivation has a more positive effect on learning effectiveness, compared with extrinsic motivation. This emphasises the importance of alignment between learning objectives, teaching/learning activities and assessment (Biggs & Tang 2011). This is also indicated in their study, in which a marginally higher percentage is given to preparing for exams compared with project work.

After the examinations, students receive the examiner's guidance, showing what is expected for full marks (i.e., the solutions to the problems). The students should use this for learning. It gives them indications of where there are gaps in knowledge and skills.

Change, confirmation and/or comprehension

Feedback can give students valuable insights, although this depends on how it is given (Winstone & Carless, 2019; Hattie & Timperley, 2007). Studies by Hattie (2011) and Kluger and DeNisi (1996) suggest that feedback under given conditions can have a minimal or unwanted effect on performance. Nevertheless, feedback could support students with relevant information on where they stand in regard to their work, such as feedback underlying project work score, complemented with an evaluation of their basic theoretical knowledge – being the foundation for the course and project work – such that there is a basis for improvement and a deeper understanding. But, as indicated above, this requires feedback with quality.

The examination feedback also gives some indication to the lecturer regarding the quality of the course design. If many students perform poorly, question the evaluation or file complaints, this might call for reconsideration of the course design.

Assumptions and framework conditions

That students spend time on the courses is often seen as a key to in-depth learning. However, it does not matter how well the courses are designed, if students are not spending time or doing what is required to achieve the learning objectives. Students can be informed about what is expected of them; however, there might be personal circumstances making it difficult to meet these expectations. For example, they might have other commitments limiting their availability and their ability to contribute to the learning environment, such as paid work or other courses that they attend. The same goes for the lecturers, who might have a time budget, limiting the time to spend on supervision, which might influence flexibility and quality.

Classroom design and digital opportunities and requirements could play a role in student activity and learning environment. A digital arena might, for example, pose a challenge for students to establish project groups with good dynamics. We refer to Morrison and Camargo-Borges (2016), for further discussions on the opportunities and challenges related to digital learning environments.

Course evaluation

After the courses are completed, students are encouraged to give input for evaluation purposes. This feedback is valuable to the lecturers, for example for the design and preparation of future courses, but many

students do not see the value of this and fail to give appropriate feedback. If only a few students submit their opinions, then the course's adjustment might be misguided and lead to changes that do not favour learning for students on future courses.

Adjustment of courses might also be misguided if the course evaluation does not collect information about factors important for learning. The evaluation questionnaires and report templates used by the university to evaluate teaching and learning are insufficient, leaving it up to the individual lecturer to collect any additional information about their teaching and students' learning. This is not a viable approach, as teacher education appears not to focus on the development of evaluation skills for teachers (cf. McFadden & Williams, 2020). A predefined evaluation questionnaire or report template would therefore be helpful. However, a prerequisite for this, to aid teachers, is that the questionnaire/template is designed in accordance with factors important for teaching and learning, thus aligning measurement approaches with the conceptual understanding of teaching (cf. White et al., 2022). The model presented in this paper may be a promising alternative to use as a basis for describing, analysing and evaluating learning in higher education. Further, the Norwegian national student survey covers the factors in the model in a suitable way, enabling the collection of necessary information about teaching and learning, but needs to be used on each course to give the full benefit. An evaluation questionnaire or report template based on the model developed will also be helpful for institutions, as it will enable universities to evaluate teaching quality more objectively (cf. Wang & Williamson, 2022) and obtain a quality system that produces knowledge about the mechanisms that hinder and promote learning (cf. Gynnild, 2007), in addition to evaluating teachers' employee performance (cf. Lohman, 2021).

A final note regarding the questionnaire. This was given to students after completion of the course and covers the full population, i.e., the two courses (n=45). This makes the feedback representative, in terms of their experiences on these, but this is not normally the situation when receiving evaluation scores from students. Especially when only a fraction of the students submits their scores, there is a challenge in assessing whether the feedback represents the general opinion in the class. For the questionnaire, the students were asked to fill this out on site, anonymously, which is the main reason why so many completed it. Besides, as overall student satisfaction on the courses was quite high, there is a possibility that students had a positive attitude towards the current design when giving their answers.

CONCLUDING REMARKS

The model presented is relevant for describing, analysing and evaluating learning in risk management education, with a focus on experiences from a master's programme in risk and safety management at a Norwegian university. The model is holistic and student-centred and particularly highlights the role of reflection in the learning process. Reflection is seen as essential for in-depth learning, just as in the emergency response context. It builds students' ability to develop knowledge and skills from the experiences collected through participation in various learning activities. Appropriate learning activities must thus be tailored such that students are able to achieve the intended learning objectives. To support this tailoring, we refer to aspects emphasised in the literature as important for learning in higher education, such as constructive alignment, the necessity of student engagement and activity, giving formative feedback to students, and frame conditions provided by the teaching institution, as well as aspects not addressed. The model adds to existing literature by representing a suitable frame for how these aspects interact and influence learning. It can be used to achieve course designs and learning environments in which both social and individual learning approaches are considered.

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Integrating Elements of Statistics and Corporate Finance to Solve Insurance Renewal Options

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ABSTRACT

During hard insurance markets, organizations of all sizes and shapes are often forced to consider treating loss exposures with non-traditional risk financing options instead of transferring loss exposures using traditional insurance. This paper demonstrates how one organization incorporated essential statistical tools and elements of corporate finance to assess its options for dealing with the renewal of its workers' compensation coverage during a hard insurance market environment.

Background

This case is based upon the author's twenty-five plus years of experience in risk management and insurance as a Fortune 500 risk manager and insurance broker. The contents of the case and the models used in the case are taken from the author's experiences and represent the author's original works. The company in the case, All American Pumps (AAP), is not an actual company; however, AAP is based on a composite of actual companies the author has worked with over his career. The case illustrates risk management problems students will face in real-world situations.

Course Appropriate

This case is appropriate for professors teaching a capstone risk management and insurance (RMI) class. RMI capstone classes are usually the final RMI course for an RMI major. The case is based on the expectation that students and readers of the case have a clear understanding int the following areas: risk management and insurance terminology, fundamentals of basic statistics, and introduction to corporate finance. Proficiency in Excel is not necessary for the case; however, for the assignment in the appendix, if one chooses to assign the appendix, proficiency in basic Excel is necessary

The primary learning objectives are:

1. Apply knowledge from core business classes, namely statistics and corporate finance, to solve risk management problems.
2. Develop models and use the models' output to arrive at solutions to risk management problems.
3. Recognize that new risk management solutions must be communicated within an organization.

Professors can use this case in two formats. Firstly, have the students read the case, hold classroom discussions, and answer the questions at the end of the case (suggested answers are included in the questions section of the case.) Secondly, one could use the case as a set-up for a homework assignment. After completing the first format, change the data set and have the students compute all numbers based on the new data set. The new data set along with completed modeling from the new data set, are shown in the appendix to the case. The homework assignment provides students with practice and skills for calculating the case's quantitative aspects.

The Case

Introduction to Teresa Martinez, CPCU, ARM

Teresa Martinez, CPCU, ARM, works as a producer (known outside of the insurance trade as a salesperson) for a national insurance broker. She is located in the firm's New York City office. Teresa specializes in delivering risk management solutions, not just traditional insurance. Ms. Martinez holds a BBA degree with a major in Risk

Management and Insurance from a public university with an excellent reputation in risk management and insurance. She also has an MBA and over ten years of work experience. Her duties focus on prospecting and calling on middle-market-sized accounts, many of whom do not have a full-time risk manager. Teresa tries to differentiate herself from her competitors by delivering sophisticated risk management solutions to her prospects and clients rather than simply selling traditional insurance solutions. Many of her prospects and clients currently purchase only insurance. In summary, her business development strategy is to bring risk management solutions to various companies, thereby helping these companies solve risk issues at a potentially lower cost.

All America Pumps (AAP)

Martinez has called on All America Pumps for several years. AAP is located in Connecticut, and its annual sales are nearly $400 million and employs a workforce of 1,025 people depending upon production schedules. "The Company's product line consists of pump models ranging in size from 1/4" to 84" and ranging in rated capacity from less than one gallon per minute up to 500,000 gallons per minute. The types of pumps which the Company produces include self-priming centrifugal, standard centrifugal, magnetic drive centrifugal, axial and mixed flow, rotary gear, diaphragm, bellows and oscillating.

Virtually all materials, supplies, components, and accessories used by the Company in the fabrication of its products, including all castings (for which most patterns are made and owned by the Company), structural steel, bar stock, motors, solenoids, engines, seals, and plastic and elastomeric components are purchased by the Company from other suppliers and manufacturers.

The other production operations of the Company consist of the machining of castings, the cutting, shaping, and welding of bar stock and structural members, the manufacture of a few minor components, and the assembling, painting, and testing of its products. Virtually all of the Company's products are tested prior to shipment." The manufacturing and assembly are labor intensive because the pumps are essentially hand built. Hourly employees account for approximately 85% percent of the company's payroll.

AAP's balance sheet is in pristine shape. The company has no debt, and its weighted average cost capital (WACC) is 8%. The company has paid a dividend since its inception 1940.

Meeting with Fred Smith

After Martinez's numerous attempts to meet with Fred Smith, AAP's VP and Treasurer, Smith finally agreed to meet with Martinez. Like many mid-sized enterprises (MSE), Smith wears many hats and oversees AAP's risk and insurance matters part-time. Smith is highly dependent on AAP's current insurance broker to handle the company's risk and insurance issues.

Smith agreed to meet with Martinez because Smith was not pleased with his prior year's workers' compensation renewal. He thought the price was too high given AAP's good loss history. Also, Smith knew the insurance market was still hard, and he knew it was necessary to seek other options for AAP's upcoming workers' compensation renewal. Haunted by last year's renewal and knowing the insurance market was hard, Smith was determined not to be held hostage by the vagaries of the property and casualty industry's market cycles; therefore, Smith commissioned Martinez to compete on AAP's workers' compensation renewal.

Invite to compete

The invitation to propose solutions for AAP's upcoming workers' compensation renewal thrilled Martinez; however, she knew she would have to be creative and provide viable solutions to win AAP's next workers' compensation insurance renewal. After considering several potential solutions for AAP's next workers' compensation renewal, Martinez realized she needed the following information: workers' compensation incurred loss history, experience modification factor, history of person-hours worked, and estimated person-hours for the next policy period. Smith provided Martinez with the requested information. Exhibit 1 below shows the requested information in detail.

Exhibit 1

Years	Person Hours Worked	Ultimate WC $ Losses*
2016	2,096,854	1,093,217
2017	2,325,758	1,212,693
2018	2,171,421	1,116,166
2019	2,091,656	1,085,557
2020	2,169,393	1,131,652
2021	2,205,197	1,198,112
Total	13,060,279	6,837,397

Estimated person-hours for 2022 = 2,135,460
*Using person-hours instead of payroll because person-hours do not require trending, and payroll would have to be trended.
** Martinez obtained actual incurred loss data from AAP's loss runs and had her company's actuary trend and develop incurred losses to ultimate.

Martinez's review and strategy

After Martinez carefully reviewed AAP's loss history and Smith's objectives, she quickly concluded that a traditional guaranteed cost insurance program would not work for AAP's upcoming workers' compensation renewal. Martinez was convinced AAP needed some kind of loss sensitive program for its workers' compensation renewal. Loss sensitive programs include the following type of programs: true self-insurance (i.e., a qualified self-insurer), high deductible plan, self-insured retention (SIR) or possibly a captive arrangement.

Martinez believed a high deductible plan (HDP) with a per occurrence deductible of $250,000 and an annual aggregate stop-loss of $1.3 million would best suit the needs of AAP. She thought this because the HDP essentially emulated qualified self-insurance without all the filings and administrative duties required by the state. Martinez also felt AAP was not ready for a captive, and the HDP would be an excellent first foray into "quasi self-insurance."

Let the number crunching begin

Martinez realized she had to do number crunching in two areas for her AAP proposal. First, Martinez had to forecast a loss-pick for AAP, an estimate of AAP's workers' compensation losses for the upcoming annual renewal period. Martinez knew that several concepts from her statistics classes could be applied to AAP's loss data to arrive at an appropriate loss-pick.

After arriving at a loss-pick, Martinez needed to apply an after-tax present value (PV) cash-flow model to her loss pick. Martinez believed the concepts she learned from her MBA finance classes would be applicable. Furthermore, Martinez knew her potential client Fred Smith, VP and Treasurer of APP, as a financial professional, would understand and appreciate this approach.

Martinez used the following steps and data for calculating the loss-pick and PV after-tax results:

1) Calculate a loss forecast using three (3) methods: linear regression, standard deviation, and experience rating.

2) Add the results of all 3 methods from step 1 and average the 3 results. The average will be the loss pick for the after-tax cash flow analysis. **Note:** Use the high-end number from the 3rd standard deviation for the standard deviation method.

3) Once the loss pick is determined, complete an after-tax cash flow analysis.

4) Compute the guaranteed cost premium (traditional insurance with full transfer of risk).

Other information Martinez needed to complete this analysis

A) The payout profile (paid claims) for the loss-pick is as follows: Year 1 - 30%, Year 2 – 25%, Year 3 – 20%, Year 4 – 15%, Year 5 - 10%.

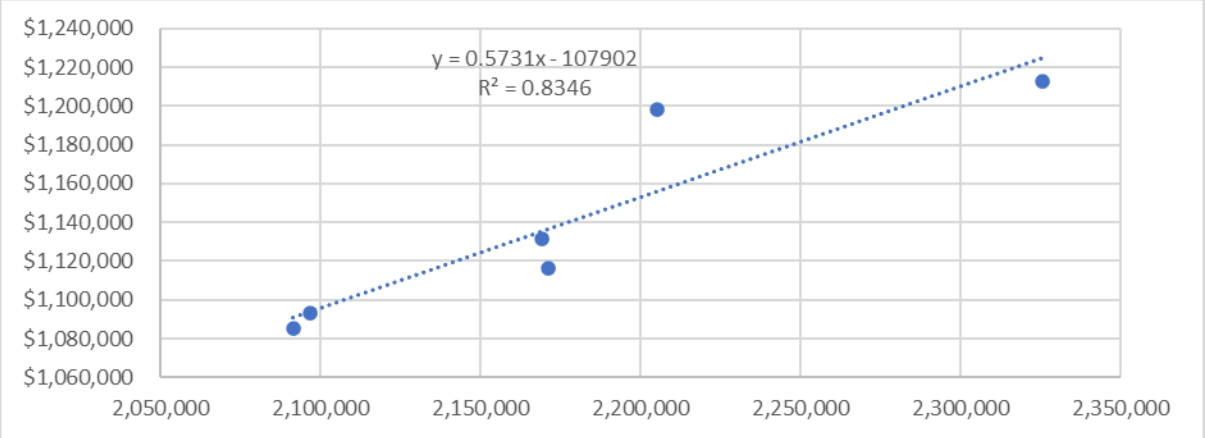
B) The Third-Party Administrator (TPA) fee is 12% (Includes fronting fee, claims handling expenses, costs for per occurrence deductible and aggregate stop-loss).

C) AAP's weighted cost of capital (WACC) is 8%; therefore, the Present Value Interest Factor (PVIF) should be on a mid-year basis since not all losses are paid at the end of the year. For example, year 1 PVIF should be $1/1.08^{.5}$ and year 2 PVIF should be $1/1.08^{1.5}$, etc.

D) The collateral fee is 2.5% - applied on the full loss-pick for year 1, for successive years the collateral fee is applied to outstanding losses (loss-pick minus cumulative paid losses). "If an insured has a large deductible for its commercial lines business, the carrier will require collateral to protect itself against the credit risks related to the structure".[21]

E) AAP's tax rate is 30%.

Loss-pick – 3 methods



1) Linear regression – inserting 2022 estimated person hours of 2,135,460 into the above regression formula results in a loss-pick of **$1,115,930**.

2) Experience rating – dividing ultimate WC losses ($6,837,397) by person-hours worked (13,060,279) yields a loss cost per hour of .52. .52 x 2,135,460 (2022 estimated person-hours 2,135,460) provides loss-pick #2 of $**1,110,439**.

3) Standard deviation – the mean for loss years 2016 through 2021 is $1,139,566 and the standard deviation is $49,076. Using high end of three (3) standard deviations (99.73% - to be conservative), the loss-pic is **$1,286,794** ($1,139,566 + 3 X $49,076).

Averaging the three (3) loss-picks methods equals $1,171,054.

Present value after-tax cost comparison of the HDP v. Insurance renewal

	Year 1 P/O = 30%	Year 2 P/O = 25%	Year 3 P/O = 20%	Year 4 P/O = 15%	Year 5 P/O = 10%
Forecasted Losses Paid Out	351,316	292,764	234,211	175,658	117,105
TPA @12%	42,158	35,132	28,105	21,079	14,053
Collateral 2.5%	29,276	20,493	13,174	7,319	2,928
Pre-Tax Costs	422,750	348,389	275,490	204,056	134,086
Less Tax @ 30%	126,825	104,517	82,647	61,217	40,226
After Tax Cost	295,925	243,872	192,843	142,839	93,860
PVIF at 8% (Mid-Year Discounting)	0.9623	0.8910	0.8250	0.7639	0.7073
PV A/T Cost	$ 284,769	$ 217,290	$ 159,095	$ 109,115	$ 66,387
Sum of PV A/T Cost Years 1-5	$ 836,656				
Renewal Insurance cost w/incumbent*	$ 1,446,259				
Less Tax 30%	$ 433,878				
PV After tax cost of insurance	$ 1,012,381				
PV A/T Cost of HDP		$ 836,656			
PV A/T Cost of Insurance		$ 1,012,381			
Potential savings on HDP v. Insurance		**$ 175,725**			
Details of Insurance Renewal		Estimated	Rate	Estimated	
Estimated Payroll for 2022 is $70,000,000		Annual	Per $100	Annual	
Classification	Code	Remuneration	Remuneration	Premium	
Office	8810	$ 7,000,000	0.18	$ 12,600	
Sales -Outside	8872	$ 1,000,000	0.36	$ 3,600	
Pump Manufacturing	3612	$ 62,000,000	2.74	$ 1,698,800	
Total Subject Premium				$ 1,715,000	
Experience Premium = .90 (Mod=.10)				$ (171,500)	
Total Modified Premium				$ 1,543,500	
Premium Discount = 6.3%				$ (97,241)	
Final Total Estimate Premium				$ 1,446,259	

* The author provided the details of the insurance renewal with the exception of rates per $100 of remuneration. R rates per $100 of remuneration (*CBIA workers comp*. Government Affairs).

QUESTIONS

These questions are designed to cover and promote comprehension, reasoning, and analytical thinking.

1) Q. What is the independent variable in the linear regression in this case?

A. Person hours worked

2) Q. What is the dependent variable in the linear regression in this case?

A. Ultimate WC Losses

3) Q. What is another name for R squared?

A. Coefficient of determination

4) Q. What does R squared tell us?

A. The value R squared represents the proportion of variance in the dependent variable that can be explained by the independent variable

5) Q. What is the advantage of using person-hours worked v. payroll?

A. Person hours do not need to be trended or developed, and it saves on actuarial costs.

6) Q. How are ultimate losses derived?

A. Incurred losses (paid + outstanding case reserves) are trended from a given date using cost indices (medical costs and wages for workers' compensation) and then an LDF (loss development factor) is applied to arrive at ultimate losses – the date when all claims occurring during a policy period are finally settled.

7) Q. What is the difference between ultimate losses and incurred losses (paid + outstanding, also known as case reserves)?

A. IBNR, incurred but not reported

8) Q. Was Teresa Martinez a good producer/salesperson?

A. Yes, because she has many of the attributes often cited for success in sales.

- Good listener – she listened to what AAP's and Fred Smith's needs were.
- Relentless – she called on Fred Smith numerous times.
- Product knowledge – she knew what products (cash flow plans) would solve AAP's and Fred Smith's problems (high prices in a hard insurance market).
    - Her product knowledge was enhanced by:
        - Her education in risk management.
        - She understood statistics and finance via her MBA.
        - She had further professional knowledge – CPCU and ARM certifications.

9) Q. Why should Fred Smith accept Teresa Martinez's proposal for the high-deductible plan(HDP)?

A. The HDP reduces AAP's workers' compensation cost for 2022 by $175,725 or 17% less than the alternative, and it gets AAP out of the roller coaster ride of hard and soft insurance markets.

10) Q. Besides lower cost, what could give Fred Smith confidence in his decision to choose the HDP?

A. The HDP for 2022 has an annual aggregate stop loss of $1,300,000, $146,259 less than the alternative of $1,446,259.

A. The HDP is for one year; therefore, Fred Smith/AAP has flexibility if things change or don't work out as expected.

11) Q. Whom should Fred Smith notify within AAP about the change from guaranteed cost to the HDP?

A. Several people within AAP – namely the following:

- All managers and supervisors, why? Smith should let all managers and supervisors know so they can communicate the change to HDP employees. Essentially the HDP is "self-insurance." Companies and workers tend to be more loss conscious when companies are self-insured. As a result, safety is heightened and takes on more emphasis.

- AAP's Controller – ASC450 will apply to AAP under the HDP.

  "ASC 450, *Contingencies*, outlines the accounting and disclosure requirements for loss and gain contingencies. An estimated loss from a loss contingency is recognized only if the available information indicates that (1) it is probable that an asset has been impaired, or a liability has been incurred at the reporting date and (2) the amount of the loss can be reasonably estimated. Loss contingencies that do not meet both criteria for recognition still may need to be disclosed in the financial statements."

12) Q. Using the loss-pick of $1,171,054 in the case as ultimate losses and assuming case reserves are $200,000, what is the value of IBNR at the of end 2022?

A. $619,738 is the value of IBNR. $1,171,054 - $551,316 (paid + case reserves)

13) Q. At a minimum, what amount should AAP expense for 2022 for its losses under the HDP program?

A. $551,316, the paid losses of $351,316 would be a reduction in cash and the $200,000 of loss reserves would be "hung up" as a liability (non-cash expense) on the balance sheet.

14) Q. How much of the $619,738 of IBNR should be expensed in APP's 2022 financial statements?

A. That depends! IBNR liabilities, especially in workers' compensation, are difficult to measure. AAP financial executives should meet with a qualified actuary and its auditors to determine this amount.

Note: AAP does not have a long loss history so it may be difficult to comply with ASC 450; therefore, AAP may need only a disclosure in its 2022 financial statements.

15) Q. What could AAP do to lower their WC losses now that they are practically self-insured?

A. Implement formal loss control programs – focused on both loss prevention and loss reduction. Safety courses and training, return to work programs and reviewing loss trends.

APPENDIX - HOMEWORK ASSIGNMENT

Complete an after-tax cash flow (ATCF) analysis of a High Deductible Plan (HDP) for workers' compensation versus guaranteed cost insurance. Upon completion of all necessary calculations, recommend an option for 2022 and explain your recommendation.

Below is the data set you will use for your analysis.

	Person Hours	Ultimate WC
Years	Worked	$ Losses*
2016	2,201,697	1,158,810
2017	2,442,046	1,285,455
2018	2,279,992	1,183,136
2019	2,196,239	1,150,690
2020	2,277,863	1,199,551
2021	2,315,457	1,269,999

*Ultimate means losses for each year have been trended and developed to reflect "ultimate" expected losses for each year.

Person hours worked for 2022 are estimated to be 2,497,500.

Directions

1) Calculate a loss forecast using three (3) methods - linear regression, standard deviation, and experience rating.

2) Add your results of all 3 methods from step 1 and average the 3 results. The average will be your loss pick for your after-tax cash flow analysis. **Note:** Use the high-end number from the 3rd standard deviation for your standard deviation method. Standard deviation should be done via standard deviation P (this is an option in Excel).This is not a sample; it is the company's loss history since the company has been keeping record of its losses.

3) Once you have your loss-pick, complete your after-tax cash flow analysis.

4) Compute the guaranteed cost premium.

5) Show all work – submit your work (this assignment) in hard copy using Excel. The assignment can be landscape or portrait, but make sure it fits on 1 page; you may print on back and front. The ATCF analysis **must be printed with gridlines.**

6) Your linear regression must show the regression formula and the R squared value.

7) Your analysis and work should follow the models/format reviewed in the AAP case.

8) Rounding – all calculations to be rounded to nearest dollar, use the rounding function in Excel.
   Note: the loss rate for experience rating should be rounded to nearest penny (2 places). Standard deviation should be manually rounded to nearest dollar.

Other information you will need to complete this assignment

A) The payout profile for your loss pick is as follows: Year 1 - 20%, Year 2 – 22%, Year 3 – 25%, Year 4 – 18%, Year 5 - 15%

B) TPA fee is 13%
C) WACC is 9% (PVIF) (mid-year discounting)*
D) Collateral 1.5%**
E) Tax rate is 35%
F) Workers' Compensation

		Estimated	Rate
Estimated Payroll for 2022: $74,000,000		Annual	Per $100
Classification	Code	Remuneration	Remuneration
Office	8810	7,400,000	0.18
Sales - outside	8872	1,100,000	0.36
Pump Manufacturing	3612	65,500,000	2.74

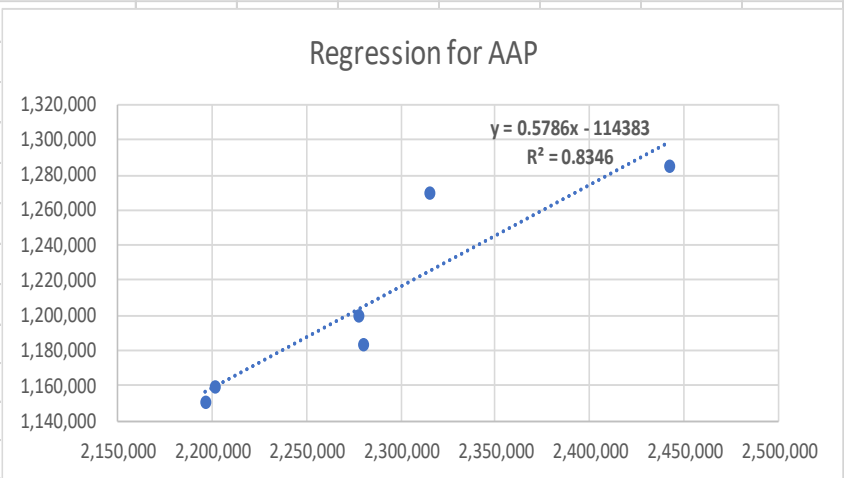
Experience Premium = .89(Mod = .11)
Premium Discount = 6%

*Year 1 = 1/(1.09^.5), Year 2 = 1/(1.09^1.5), etc.

** The collateral fee is 1.5% - applied on the full loss-pick for year 1. For successive years the collateral fee is applied to outstanding losses (loss-pick minus cumulative paid losses).

ANSWERS

	Person HRS Worked	Ultimate WC Losses*
2016	2,201,697	1,158,810
2017	2,442,046	1,285,455
2018	2,279,992	1,183,136
2019	2,196,239	1,150,690
2020	2,277,863	1,199,551
2021	2,315,457	1,269,999



*Ultimate means losses for each year have been trended and developed to reflect "ultimate" expected losses for each year.

Estimated person hours for 2022 are: 2,497,500

Forecasted losses for 2022 are: Y= 0.5786 X 2,497,500 - 114,383 = **$1,330,671**

Regression via Excel (Insert, Charts – scatter, + chart elements – trendline, linear forecast, more options, display equation on chart, display R squared value on chart)

Mean losses (2016-2021)	$1,207,940					
1 std dev.	$52,021					
3 std dev.	$156,063					
$1,207,940 + $156,063	$1,364,003	Est. losses for 2022				
	Historic	Historic	Historic			
Historic=Years 2016-2021	Total Losses	Total Hours	Loss Rate(HLR)			
Loss Rate	$7,247,641	13,713,293	$0.53			
Estimated hours for 2022 X HLR		2,497,500	$0.53	$1,323,675.00	Est. losses for 2022	
Regression	$1,330,671.00					
Std dev.	$1,364,003.00					
Loss rate	$1,323,675.00					
Loss Pick 2022	$4,018,349.00	/3	$1,339,450.00			

Loss Pick	$ 1,339,450	Payout (P/O) per Years 1-5			
	Year 1 P/O = 20%	Year 2 P/O = 22%	Year 3 P/O = 25%	Year 4 P/O = 18%	Year 5 P/O = 15%
Forecasted Losses Paid Out	267,890	294,679	334,863	241,101	200,918
TPA @13%	34,826	38,308	43,532	31,343	26,119
Collateral 1.5%	20,092	16,073	11,653	6,630	3,014
Pre-Tax Costs	322,808	349,060	390,048	279,074	230,051
Less Tax @ 35%	112,983	122,171	136,517	97,676	80,518
After Tax Cost	209,825	226,889	253,531	181,398	149,533
PVIF at 9% (Mid-Year Discounting)	0.9578	0.8787	0.8062	0.7396	0.6785
PV A/T Cost	$ 200,970	$ 199,367	$ 204,397	$ 134,162	$ 101,458
Sum of PV A/T Cost Years 1-5	$ 840,354				
Renewal Insurance cost w/incumbent	$ 1,515,902				
Tax 35%	$ 530,566				
PV After tax cost of insurance	$ 985,336				
PV A/T Cost of HDP		$ 840,354			
PV A/T Cost of Insurance		$ 985,336			
Potential savings on HDP v. Insurance		**$ 144,982**			
Details of Insurance Renewal		Estimated	Rate	Estimated	
Estimated Payroll for 74,000,000		Annual	Per $100	Annual	
Classification	Code	Remuneration	Remuneration	Premium	
Office	8810	$ 7,400,000	0.18	$ 13,320	
Sales -Outside	8872	$ 1,100,000	0.36	$ 3,960	
Pump Manufacturing	3612	$ 65,500,000	2.74	$ 1,794,700	
Total Subject Premium				$ 1,811,980	
Experience Premium = .89 (Mod=.11)				$ 199,318	
Total Modified Premium				$ 1,612,662	
Premium Discount = 6%				$ 96,760	
Final Total Estimated Premium				$ 1,515,902	

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Teaching Safety Risk Management: On The Importance Of Integrating Economic And Safety Perspectives

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ABSTRACT

When teaching risk management, within the area of safety, the main focus is typically on safety management principles. The basis for these principles, and for traditional safety thinking, is the adoption of a cautionary mindset (cautionary principle), where attention is given to uncertainty, what could happen in the future and how to reduce or avoid possible consequences. In this paper, we point out the importance of also paying some attention to economic principles, to facilitate good resource utilization. Resources are in general scarce, and a stronger weight placed on the uncertainties than should be done from a traditional economic perspective may contribute to a sub-optimal use of resources. Even if the scope is limited only to risk management, negative impacts on safety may then occur. However, as the traditional economic perspective in some situations may also contribute to too little weight being placed on the uncertainties, we argue for the importance of integrating safety and economic perspectives when teaching safety risk management.

Key words: teaching, higher education, risk management, safety, economic perspectives, safety perspectives, uncertainty

INTRODUCTION

Risk management refers to coordinated activities to direct and control an organisation with regard to risk (ISO 31000, 2018) and, as such, addresses the challenge of balancing value creation and risk. When teaching risk management, within the area of safety, the focus is usually on the importance of giving strong weight to the uncertainties and to the potential for accidental events to occur (Abrahamsen and Abrahamsen, 2015; Abrahamsen et al., 2018; Möller and Hansson, 2008), with a principle of caution when facing uncertainty and potentially severe events being adopted. Aven (2019) refers to it as a 'cautionary principle'.

In this paper, we ask whether safety management principles and strong weight placed on the uncertainties should be the only basis for safety risk management. The question is fundamental and principally important for ensuring good quality in teaching safety risk management and candidates that are equipped to take part in the

decision processes in various organisations. The question is of special interest, as the prevailing safety thinking, which forms the basis for teaching safety risk management, is in clear contrast to the economic thinking, where decision-making is based on expected value considerations (Varian, 1999). This may marginalise the impact of safety science and lead to outcomes where limited weight is then given to the uncertainties and the potential for extreme consequences to occur.

With reference to the difference between safety and economic perspectives, in this paper, we discuss whether the economic principles, theories and methods should be incorporated into safety risk management. We show that traditional economic thinking must be incorporated and should be considered an equally important element as the ruling principles in safety management. Without integrating the economic and safety perspectives in safety risk management, the basis for giving good decision support and thereby facilitating good decisions is weakened. We highlight that such a focus is of crucial importance when teaching safety risk management.

This paper is organised into five sections, including the introduction section. Section 2 provides a brief presentation of the safety expert's approach to safety risk management. Attention is paid to prevailing safety management principles, such as the cautionary- and precautionary principles and the ALARP principle. Section 3 focuses on the economist's approach to safety risk management, where the focus is on economic principles, theories and methods. In section 4, we discuss whether the integration of economic and safety perspectives when teaching safety risk management is important or something to avoid. Finally, in Section 5, we draw some conclusions.

A SAFETY EXPERT'S APPROACH TO SAFETY RISK MANAGEMENT

As already mentioned, risk management refers to coordinated activities aimed at directing and controlling an organisation with respect to risk. From a safety expert perspective, the approach to risk management (HSE, 2001) typically includes:

- identifying what could cause injury or illness in the workplace (i.e., identifying the hazards)
- deciding how likely it is that someone will be harmed and how seriously (e.g., quantifying the risk)
- intervening to eliminate the danger or control the risk (i.e., managing the risk)

The process covers a variety of sub-tasks aimed at establishing a continuous improvement framework for managing risk. This framework integrates a set of principles and a process for how to perform risk analysis in general (ISO 31000, 2018). An objective is to strengthen risk-informed decision-making. Within this scope, there are several tools and principles, in addition to traditional risk analysis. For instance, the economist's toolkit includes expected utility theory, cost-benefit and cost-effectiveness analysis and expected net present value. However, in real-world applications, a challenge is to understand the strengths and weaknesses of different approaches.

Uncertainty might be highlighted as a main attribute of risk. In addition to uncertainty, Aven (2018) also points to the consequences of the activity. These consequences represent a value judgment. When describing the risk, the assessor would then combine the potential consequences, which could be a potential economic loss, and the associated uncertainties must also be expressed. These are often expressed using probabilities. Both attributes are assessed, i.e., the consequences and uncertainties, conditional on the knowledge of the one(s) analysing the situation (Abrahamsen et al., 2018). Hence, two different analysis teams may assess the risk differently, as they might have a different understanding of what might happen and how likely it is.

From a safety expert's approach, the cautionary principle will guide the emphasis of risk in the situation of interest (Aven, 2019). For situations with a significant potential for severe consequences, it is seen as reasonable to mitigate these or to avoid them entirely. According to Aven (2019), the cautionary principle states that: "in the face of an activity subject to serious consequences or uncertainty, cautionary measures, such as implementing risk-

reducing measures or not carrying out the activity, should be taken". Aven and Vinnem (2007) add that the need to be cautious when working with risk and uncertainties is also reflected when designing safety regulations.

Sometimes, when there is significant "scientific uncertainty" regarding the consequences, a variant of the cautionary principle is referred to, i.e., the precautionary principle. This variant states that if "the consequences of an activity could be serious and subject to scientific uncertainties, then precautionary measures should be taken, or the activity should not be carried out" (Aven, 2019). This emphasises the need to be careful, particularly in situations where there is lack of understanding related to what might happen.

Focusing on the cautionary principle in general, one way to operationalise this is to have risk reduced to a level that is As Low As Reasonably Practicable (ALARP). When managing risk according to ALARP, considered measures should be implemented unless they are grossly disproportionate to the obtained benefits (HSE, 2001). This is a way to place weight on safety aspects in decision-making, as any risk-reducing measure should be implemented, unless there is a strong argument against it (Abrahamsen et al., 2018). The argumentation is typically derived through traditional cost-benefit analysis (Ale et al., 2015).

Aven (2011) is critical of decision-making based solely on expected values, being the premise for cost-benefit analyses. To ensure ALARP leans more towards protection than value creation, a layered approach, capturing underlying uncertainties, is proposed (Aven, 2011). This is a three-step approach: Step 1 being a crude analysis of costs. If the costs are low, the measure should be implemented; there are not strong enough arguments against it. For higher costs, a more detailed analysis is called for, which is performed in Step 2 by a cost-benefit analysis. If this analysis gives a positive result, then the measure should be implemented. For a negative result, where expected costs are higher than expected benefits, one should move to Step 3. In this, a checklist is referred to for the assessment of other issues, such as level of uncertainty and manageability concerns (see, e.g., Abrahamsen et al., 2018).

AN ECONOMIST'S APPROACH TO SAFETY RISK MANAGEMENT

According to the economist's perspective, the expected utility theory is fundamental for making decisions in situations characterised by uncertainty (see e.g., Bedford and Cook, 2001; and Levy and Sarnat, 1994). The theory provides a logical framework for making decisions under uncertainty, using a probabilistic approach. It represents an optimal way for someone consistent in consequence uncertainty judgements to make decisions (Lindley, 1985). However, despite its logical and theoretically attractive appearance, a main obstacle is the challenge of measuring utility (Lindley, 1985). Hence, there are simplified approaches, consistent with maximising expected utility, but in which the simplifications are introduced through additional assumptions. The most common of these tools is the traditional cost-benefit analysis. In this, all attributes covering the utilities are expressed as costs and benefits in terms of monetary values, which traditionally reflect the amount society would be willing to pay to achieve some resource or to obtain a specific benefit (Varian, 1999). Monetary values are easily comparable and are generally not as difficult to determine, compared with non-market goods (Abrahamsen et al., 2011).

In benefit cost analysis, the pros and cons of an activity or project are assessed and expressed as an expected net present value, E[NPV]. For the calculation of the E[NPV], costs and benefits must be specified for the relevant periods, with a discounting rate (Levy and Sarnat, 1994). The sum of the expected benefits and costs in a given period t, $E[X_t]$, is given by the estimated costs and benefits occurring in that period. For a typical safety investment, in the first period there will only be costs, as this involves the cost of setting up the measure. In later periods, the expected benefits are calculated as the expected value of avoiding accidents, and the expected cost will be the cost of maintaining the safety measure. The $E[NPV(r_t)]$ is calculated by the following expression:

$$E[NPV(r_t)] = \sum_{t=0}^{T} \frac{E(X_t)}{(1+r_t)^t} \quad (1)$$

which gives the net present value of the measure over its lifetime from time 0 to T (often in years). In (1), r_t denotes the (expected) discount rate for year t. For the time period considered, the discounting of the cashflow by an appropriate rate of return will reflect the impact of benefits and costs occurring at different time periods in the E[NPV]. To adjust for, e.g., compensation expected in risk-taking, Varian (1999) points to the Capital Asset Pricing Model (CAPM). We refer to Varian (1999) for further details.

In the cost-benefit analysis, the analyst should include all relevant attributes, such that all pros and cons are accounted for in the result. The measure is beneficial if the $E[NPV(r_t)]$ is positive, and the expected costs are larger than the expected benefits if it is negative. The underlying idea is that, when the value for all the attributes is accounted for, a positive expected net present value will ensure projects with the best use of the decision maker's resources (Varian, 1999). A premise is then that all attributes are expressed in monetary values, which some argue is challenging, as there could be non-market, intangible goods that it is immoral and illogical to monetise (Ale et al., 2015; Aven and Kørte, 2003). However, economists will argue that, if one is not comparing all values to a common unit, money, they can deduce the implicit value of different alternatives to the decision maker, based on their incurred expenses on resources (Viscusi et al., 2019). As such, making the conversion to money makes the basis for the decision transparent.

An alternative that accounts for the criticism that there are things that should not be given a monetary value is the cost-effectiveness analysis. Such an analysis is carried out without explicitly specifying the monetary value of benefits, only the costs. It allows non-monetary indices. For example, for situations with the potential for loss of lives, expected cost per expected saved life can be used instead of the value of a statistical life (Abrahamsen et al., 2004). This will give the same outcome if the measure has only one effect, i.e., the number of saved lives. However, it becomes more problematic if there are different outcomes. For instance, how does one compare the cost of a saved life to the cost of avoiding serious injury?

There are also other alternatives, e.g., multi-attribute analysis, presenting the effects for a range of attributes, without converting them into comparable units; return of investments, which measures the expected return relative to resources invested; it also possible to perform cost-benefit analysis in a more pragmatic way, by avoiding any reference to objective correct values and non-market goods (Aven, 2014).

ON INTEGRATING ECONOMIC AND SAFETY PERSPECTIVES WHEN TEACHING SAFETY RISK MANAGEMENT. USEFUL AND IMPORTANT OR SOMETHING TO AVOID?

As we have seen from the previous sections, different perspectives exist regarding safety risk management. When teaching safety risk management, attention is mainly given to safety perspectives. Strong weight is then placed on the uncertainties. The question is then whether or not it is useful to incorporate economic thinking when teaching safety risk management.

Firstly, from an economist's point of view, decisions under uncertainty should be based on expected values, as described in the previous section (Varian, 1999); this is to ensure the efficient use of resources. In safety literature, several authors are critical of the practice of decision-making under uncertainty, where decisions follow from the calculation of expected values alone (Ale et al., 2015; Watkiss et al., 2015; Abrahamsen et al., 2004). In addition to the argumentation that monetising non-market goods might be challenging, there is a claim that expected values give insufficient weight to associated uncertainties and that relevant background knowledge is ignored. Background knowledge is fundamental for the calculation of the expected values. An example of this is a project being part of a portfolio, in which project outcomes could be severe. One may, for this project, question whether it is acceptable to ignore unsystematic risks. From an economic perspective, it might be, if there is a risk attitude in conflict with cautionary thinking. It should be added that expected values in general do not necessarily give good predictions of what will be the actual outcomes. The actual outcomes (consequences) could be severe,

despite a low expected value. Abrahamsen et al. (2004) argue that, in general, expected values should be used with care and also that there is a need to somehow better reflect associated uncertainties.

In relation to the use of expected values, Langdalen (2020) points also to the effects of corporate procedures. Corporate procedures refer to a collective mindset inside an organisation. One could perhaps argue that the mentioned portfolio will consist of some projects supported by weak knowledge and some by strong, in total summing up to around zero, and making the strength of knowledge for individual projects less important. Abrahamsen et al. (2004) argue that such thinking is flawed, as the corporate procedures will not be perfectly diversified. It will be possible, in some way, to influence the portfolio value, without the decision maker being fully aware that it is happening.

Based on the above arguments, we may ask whether a focus exclusively on safety management principles is appropriate and should be the prevailing practice when teaching safety risk management – without special attention being paid to economic principles, theories and methods.

We believe that such a focus is unfortunate as a basis for teaching safety risk management. However, despite the challenges in using expected values, there are also benefits in the context of safety risk management (Abrahamsen et al., 2017). Specifically, in situations characterised by low uncertainty, strong knowledge and minor expected consequences, it is difficult to argue against a decision-making approach with reference to $E[NPV(r_t)]$. Greater emphasis on uncertainty than is the case through expected values will only lead to limited resources being used sub-optimally. A result will very likely be less safety from the available resources/money. For such situations, adopting safety management principles and the prevailing safety thinking may give less safety.

We will argue that the basis for good risk management is to think dynamically, meaning that, in some decision-making contexts, one should make automatic decisions using expected values, while, in other contexts, strong weight should be given to the uncertainties, with no link to cost-benefit analyses. In most cases, one will find oneself between the two extremes.

One concrete approach is to adopt a fully dynamic approach for decision-making under uncertainty by using the ALARP-principle, as suggested in Abrahamsen et al. (2017; 2018). There are different ways to interpret this principle. It may be interpreted in a highly conservative way, with strong weight being placed on uncertainty in all situations. Clearly, there would then be situations where such an approach becomes too strict. The principle could also be interpreted such that the situation would influence how much weight is given to uncertainties. This means that, in some situations, ALARP may be demonstrated with reference to cost-benefit analysis, and without any refence to such analysis in other situations (Abrahamsen et al., 2017). Abrahamsen et al. (2017) state that, if ALARP is to function as a general decision-making principle, "[…] it must be interpreted in a way that allows it to range from one extreme to another, i.e., a dynamic way, as it is not considered appropriate to adopt a static decision-making principle that covers all possible decision-making contexts".

The above message, on the importance of giving different weight to the uncertainties for different decision-making contexts, should form the basis for teaching safety risk management. Without such a focus, one will form a basis for the field that is inappropriate. In some situations, one will then place too much weight on the uncertainties. The scarce resources will not necessarily be used optimally. Given the available resources, less safety can then be the result. In other words, we may say that, in some situations, the prevailing safety thinking may be a threat to safety. In the same way, we may also say that focusing solely on economic theories, methods and principles when teaching safety risk management will be inappropriate from a safety point of view. Too little weight will then, in some situations, be given to the uncertainties.

It is far from an easy task to determine how much weight to place on uncertainty when balancing value creation and protection. When determining this, both economic and safety perspectives might be justified, and the optimal or appropriate way is typically a mixed approach and not an extreme one (see Aven, 2019). Aven and Kørte

(2003) add that, to follow up on the analytic results, 'managerial review and judgment' have a role in informing the decision-making, by taking into consideration the decision-making context and various aspects of relevance (e.g., policies, uncertainties and other analyses). Those making the decision will then typically have to make trade-offs in balancing value creation and protection.

When managing risk in a situation, there could be competing values and objectives, and the tools selected to assess the best way, whether strategic or principle-based, might produce different results. In addition, as already indicated, a weak knowledge base could challenge the quality, by producing misleading decision-support. There could be uncertainties concealed because of this, as the analysis might be based on weak assumptions (Patè-Cornell, 2002). Hence, it is important to capture and inform the decision maker about both the level of uncertainty and the strength of knowledge associated with the results communicated.

CONCLUDING REMARKS

In addition to the cautionary principles typical to risk and safety thinking, economic principles should also play a key role when teaching risk management. Economic principles add to the balancing of value creation and protection by facilitating proper resource utilisation. However, as there are usually limited resources available, too much weight on uncertainties compared to the traditional economic perspective may contribute to a sub-optimal use of resources. Even if the context is strictly risk management, negative impacts on safety may then occur. On the other hand, the traditional economic perspective might, in some situations, also contribute to too little weight on the uncertainties, and we argue for the importance of integrating both safety and economic perspectives when teaching safety risk management.

The importance of economic thinking is widely covered in risk management literature, and many of the models developed to support safety risk decision-making build on economic thinking. Hence, we argue that is also of crucial importance to better integrate economic and safety perspectives when teaching safety risk management. Economic thinking has a role to play as a navigator in ensuring acceptable resource utilisation, which is not achieved by adopting a strictly cautionary mindset. It is only when safety and economic perspectives are integrated that the foundation is set for achieving good teaching in safety risk management.

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The Contextual Role of Social Insurance and Industrial Age History for Teaching Workers' Compensation Insurance

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Abstract: Workers' compensation is an easy insurance coverage to teach because the policy has a simple coverage grant – injury on the job; and few exclusions, primarily use of alcohol or drugs that contributed to the accident, failure to abide by safety requirements, and whether the acts were within the course and scope of the employment. The origins of this coverage, and the decades of challenge to bring it about, allow for a study of industrial age labor practices and dangerous legal doctrines that left millions of workers dead and mutilated, all in the name of free labor and contract doctrine. There is even drama to this origin, when the New York Court of Appeals ruled in the *Ives v. South Buffalo Railway Co.* case in 1911 that the New York statute was unconstitutional, only to have the Triangle Shirtwaist Factory Fire kill 146 people the next day. On-line photographs and resources make the Triangle event easy to present, and show the compelling need and eventual enactment of workers' compensation insurance.

Workers' compensation insurance can be the easiest insurance coverage to teach and to adjust as insurable claims. It is one of the insurance programs that constitute "social insurance." The employee gets hurt on the job and unless the employee's acts were the result of being inebriated or on drugs or intentional disregard of safety protocols, the employer is liable to pay for the medical expenses and any permanent or temporary disability and income loss up to the amount set by statute. The system is strict liability (or liability without regard to fault, as Larson (1952) prefers to describe it), and mostly done through administrative proceedings of a workers' compensation board. For teaching workers' compensation as an insurance coverage, coverage questions and interpretations are few and limited mostly to facts whether the employee was on the job because of travel or being on break or working at home, and appropriateness of medical treatment decisions. (Medical treatment cases can be hard and contentious, but not important to classroom work.) Interesting claims applications arise in determining whether the employee was on the job due to technology allowing remote work and mobile work (talking to the boss on the phone while crossing the street and being hit by a car), and determining delayed onset of diseases arising from for occupational exposures (e.g. long-term hearing loss from being around railway yards[22] and factories without hearing protection), which have led to statutory presumptions for some workplace injuries.

That narrow treatment of insurance coverage is sufficient in a training program for human resources or an agent licensing course, plumped with a few definitions to memorize. In a course on business law, some brief discussion about "free labor" and "employment at-will" and employment contracts can be added because the origins of those concepts have been omitted in our current employment relations and now stand alone as concepts with incoherent definitions. In a course on commercial insurance policies, the topic of workers' compensation can be preceded with the pre-workers' compensation employer defenses to tort liability (fellow servant, contributory fault, assumption of risk). A couple of bullet points like these will add to the context of this insurance, but will add a few things for a student to remember without meaning or relevance.

[22] Railway workers are protected by federal law, Federal Employer's Liability Act, 45 U.S.C. § 51 et seq., which preceded state workers compensation laws.

In a university setting where a college course should be more than a job training, the origin history of workers' compensation insurance can be placed within the historical development of worker harms, industrialization and labor history, changes in law, risk reduction and cost-internationalization, and within the social insurance bundle of coverages of progressive legislation. Events matter, events connect, outcomes result: these narratives create meaning and purpose and rationale, something students might not appreciate in the standard curriculums of memorizing dates and definitions, but should get in a university course. Thus, the ideologies of free labor and employment-at-will arose during industrialism and were injected into the South after the Civil War in apposition to slavery, justifying oppressive work conditions in the north and the south as worker choice and implied contracts. Eventually reform was attempted through legislation to enact workers' compensation in the early 1900's. Then the New York Court of Appeals case of *Ives v. South Buffalo Railway Company*, on March 24, 1911 ruled that the New York workers' compensation statute was unconstitutional. The next day in New York City was the Triangle Shirtwaist Factory fire that killed 146 people and injured many more. Information and photos about the fire are easy to find (and listed later in this article). Nothing like photos of dead people lying on the street to impel reform in 1911, and student attention today.

This article will provide a brief overview of that industrial age history and legal history that led to workers' compensation insurance in the early 20th century,[23] and more information (and resources) about the Triangle Shirtwaist Factory fire. The information and resources here can be used in a commercial insurance policy course, and in an introduction to risk management and insurance course where workers' compensation can be embedded within the other social insurance programs.

INDUSTRIALISM CHANGED THE RULE THAT EMPLOYERS ARE LIABLE FOR THEIR EMPLOYEES' INJURIES

During the feudal period, masters were strictly liable for the harms to their servants. These were reciprocal duties owed by masters to servants (who often lived within the household), and by servants to masters. As feudalism gave way to industrialism, servants became employees, either for the household or for industrial enterprises, and the relationship was no longer governed by custom but by the evolving doctrines of contracts, which looked to agreements, real or imagined (called implied) as to duties and burdens between employer and employee, and the evolving idea of negligence (to attribute who was the cause of the injury). Absent some agreement whereby the employer would be liable for injuries to workers, the workers were on their own for medical care and lost income – meaning, neither. (Atkinson, 2013: Steinfeld, 1991; Friedman, 1985; Abraham, 1994.) This was emphatically stated in a Georgia case in 1859, *Sweet Water Mfg. Co. v. Glover* (1859), which required a contract to be shown to make the employer liable for injuries to the worker. How were employees to obtain such contracts? By negotiating for them, because *in theory* and *in ideology* employees were the equal of the employer. (Dreschler, 1959; Hart, 2009.) In early capitalism where these were small enterprises and artisans operating like guilds setting their own hours of work and conditions of employment – not yet the large incorporated firms that came later and embodied the Industrial Age – this was mostly true. (Witt, 1988; Forbath, 1985; Tomlins, 1993.) By the industrial era of the mid-1800's, with large factories employing thousands of workers, many of them destitute immigrants, that was not true. (Forbath, 1985; Witt, 1998; Hart, 2009.)

[23] This limited account here is adapted from a full article by the author on this subject, forthcoming.

AT-WILL EMPLOYMENT AND CONTRACTS

Early cases during the Industrial Age "inferred" or "implied" that laborers were masters of their own fates, responsible for their own safety, absent some agreement to the contrary. The court in *Farwell v. Boston & Worcester R.R.* (1842) said that "it may reasonably be inferred that they [employees] take the hazard of injuries from each other's negligence; …because they have, to a great extent, the means of guarding against such injuries, by the exercise of mutual caution and prudence, while the master has no such means …" Investments in safety were therefore an "employer's legally guaranteed prerogative," and "Economic necessity and the myth of the wage bargain justified this manifest and deadly inequality in the workplace," wrote McEvoy (1988.) In *Western & Atlantic Railroad Co. v. Bishop* (1873) the court upheld a waiver of liability in the employee's contract, saying that the employees must determine the contract with their employer on their own; "It looks very specious to say that the law will protect them from the consequences of their own folly, and make a contract for them wiser and better than their own."

Hart (2009) explained the circumstances of that time as individuals freely able to contract and negotiate because in theory they "were deemed to be roughly equal to each other in terms of bargaining power and access to information." Thus was justified and cemented the ideas of freedom of contract and employment at-will. As Stanley (1988) said, "In postbellum America contract was above all a metaphor for freedom, imposing social order through personal volition rather than external force. To contract was to incur a duty purely by choice and establish terms without the constraints of status or legal prescription." The legal rules were created during the 19th century to appear neutral, "as a fixed and inexorable system of logically deducible rules," wrote Horowitz (1976). Except that these rules of contract, property and commercial law "had been established during the previous half century to implement a market regime … to serve the interests of the wealthy and the powerful." (Horowitz, 1976).

The problem, rather obviously, was that this theory of equal parties contracting for labor was completely false, given the very unequal bargaining power of the large industrial enterprises against the desperate, starving laborers (Stanley, 1988; Kreitner, 2006; Eastman, 1910). Later, during the waves of immigrants that went straight to work at any job they could find practically as soon as they got off the boat, the contract could barely be implied by the courts, as reality was that there was no negotiation for wages and hours or risks, only a nod by the foreman to the earnest laborer to step forward and start working (Stanley, 1988).

With freedom of contract came the related idea of employment at-will, meaning the employee – unlike indentured servants or slaves – could choose to work, could not be compelled to work, and could quit at any time if he or she did not like the labor conditions or found a better offer. The employer could not compel the employee to work because that would be servitude (Wonnell, 1993); the employer could, likewise, fire the employee at any time. In theory, it sounds even. In practice, it meant a complete absence of any security in a job no matter how big the enterprise was (Foner, 2014; Wonnell, 1993). It also imposes serious doubts whether a "contract" that lasts minute by minute and can be abandoned at any minute, and was never actually negotiated, is actually a contract (Commons, 1924; VanderVelde, 2020). The courts nevertheless found these to be contracts sufficient to deprive the employee from receiving pay if he quit before the full day was out, and allowing the employer to change the terms of the deal with new workplace rules (Tomlins, 1993). As Witt (1988) explained, "In these respects, the nineteenth-century law of employment adopted a contractual approach to the employment relation [that] could serve to obscure and render indirect an employer's power to coerce his employees."

THE SHIFT TO NEGLIGENCE AND THE TRIAD OF DEFENSES TO DEFEAT LIABILITY

Because employers were not obligated under contract theory or feudal doctrine to protect workers and pay for their injuries, employees instead could sue employers for their harms under negligent doctrine. Here the courts in several cases (*Priestly v. Fowler* and *Farwell v. Boston & Worcester Railroad* among them) created three defenses that employers could use: assumption of risk (the employee was aware of the risks of the job and took those risks anyway); fellow servant (some other employee was actually responsible for causing the injury, not the non-human corporate employer); and contributory negligence (if the employee was even 1% at fault then he was barred from recovery. (Larson, 2023; Boyd, 1913). Plus a fourth defense: sometimes bad things happen on their own without anyone causing it – an Act of God – because if the cause was not by the employer or a fellow employee then no one was to blame. (Larson, 1952; Witt, 1988; Boyd, 1913; Fall, 1883; Gurtler, 1989). The success of these defenses meant that workers rarely won a case, and employers rarely settled a case though there were exceptions (Eastman, 1910; Witt, 2004).

The contract doctrines provided a framework too for this result. By making workplace rules part of the contract, the courts then could find the employee contributorily negligent for failure to follow some rule as to safety as the cause of his own injuries. (Witt, 1988.) This "placed the blame for accidents on the workers themselves – even in cases in which the injured employee could not have influenced or controlled the circumstances leading to the accident." (Witt, 1998.)

WORKERS' COMPENSATION BEGINS IN THE U.S.

Adoption of workers' compensation laws was swift in all countries, starting with Germany in 1884 and quickly thereafter in the rest of the Western countries, except the U.S. (Rubinow, 1913, which provides a table of the enacted schemes by country; Minkowitz, 2020.) In the U.S., the first enactment was in Maryland in 1902 but the court there overruled it as unconstitutional in 1902 (Larson, 2022). Thereafter, New York enacted its own statue in 1910, which was ruled unconstitutional in the *Ives* case (discussed below) (Minkowitz, 2020). Wisconsin is credited as the first state to have implemented and kept its workers' compensation scheme, in 1911, when the Wisconsin court in *Borgnis v. Falk Co*., (1911) upheld the law.

In the late 1800s and beginning 1900s many states established commissions to study the workplace accidents and evaluate compensatory schemes (workers' compensation) to replace the ineffective tort system of infrequent and inadequate compensation to workers. New York's Wainwright Commission in 1909 resulted in New York adopting a workers' compensation statute was one of the early states to enact workers' compensation (Minkowitz, 2020). According to Minkowitz (2020), "In 1910, the Wainwright Commission reported that the New York system was:

> 1) economically unwise, unfair, wasteful, and uncertain and claims for damages created antagonism between employees and their employers;
>
> 2) tolerable only to those who disregarded legal rights and obligations;
>
> 3) replete with evils that were most evident in hazardous employments; and
>
> 4) defective because workers in hazardous trades could not afford adequate accident insurance and in the event of a serious accident, they and their families would suffer."

The commission therefore recommended a workmen's compensation law be adopted, which the state did in 1910. (Minkowitz, 2020). Injured workers were now able to require and to obtain payment for their medical care for their long-term injuries with the costs imposed on the employer.

THE NEWS CYCLE 100 YEARS AGO MATTERED

Here is where things get interesting. Earl Ives was a railway worker for the South Buffalo Railway Company when he fell from a railway car, doing his job, and sprained his ankle (Witt, 2004). He sought recovery under the new worker's compensation law. The company went to court to overturn the law. The trial court had no problem with the statute and allowed for the recovery, saying the plaintiff-employee was injured "without negligence on the part of the defendant and without serious or willful misconduct on his part, but solely by reason of a necessary or risk or danger of his employment, or one inherent in the nature there. …" The court explained that "Prior to the enactment of the statute…, he would have been without remedy." (*Ives v. South Buffalo Ry. Co.*, 1910, at 644). Further, "The common law imposed upon the employe [sic] entire responsibility for injuries arising out of the necessary risks or dangers of the employment. The statute before us merely shifts such liability upon the employer." (*Ives*, 1910 at 645.)

Ives won at the trial court level with the court refusing to grant the company's request to dismiss the compensation claim. Having lost at the trial court level, the company appealed and obtained the result it wanted. The New York Court of Appels in *Ives v. South Buffalo Railway Company* (1911) decided that the statute was unconstitutional because it deprived the employer of the right to have a jury determine fault and damages. The court said that imposing liability on the employer "is a liability unknown to the common law and we think it plainly constitutes a deprivation of liberty and property under the Federal and State Constitutions …." (*Ives*, 1911 at 294.) The statute therefore violated the federal and state constitutions for due process of law. The court admitted the appeal of placing the risk and cost of harm on the employer, which could protect itself through insurance or raising the price of its goods to cover these costs (*Ives*, 1911 at 294.) The court said there were lots of commendable things about the statute, but it still in the end violated the due process clause and thus was unconstitutional. And then came the shadowy socialism argument, with the court saying that if this law were allowed to stand, then other laws might take even more property from the wealthy because of claims of fairness because the wealthy had more than the needed. (*Ives*, 1911, at 296.)

We think of the 24 hour news cycle as a modern, internet thing. The news cycle existed before the internet. Imagine a 24 hours news cycle 100+ years ago, with morning newspapers, evening newspapers, and special editions during the afternoon for breaking news. One day after the *Ives* decision that ruled the workers' compensation law unconstitutional, on March 25, 1911, 146 immigrant garment-factory workers, mostly women, were killed in the Triangle Shirtwaist Factory fire in lower Manhattan, many from jumping from the burning building to the ground below rather than die by fire. Journalists and photographers were there to record and report this. The building was, as we would say, a fire trap. One door was always locked to prevent employee theft, another opened inward, the door to the exterior fire escape when opened blocked the escape ladder itself and the ladder did not extend to the ground but only to the top of a skylight. No fire drills had ever been done, and none were required by law (Stein, 2011; Von Drehle, 2003). The owners of the factory escaped any criminal or civil liability (McEvoy, 1995; Von Drehle, 2003).

Francis Perkins, who later became Secretary of Labor in the cabinet under President Franklin Roosevelt, was involved in these labor reforms following the fire. She and Robert Wagner were among the commission leaders who toured other factories and found even worse working conditions and safety inadequacies: "They saw a Buffalo candy factory where chocolate boiled over into open gas flames, where the single stairway had no handrail – terribly dangerous in case of a fire – and where two toilets served three hundred workers, and one of

the two was broken." (Von Drehle, 2003: 214-215.) At another factory "Robert Wagner personally crawled through a tiny hole in the wall that gave exit to a step ladder covered with ice and ending twelve feet from the ground, which was euphemistically labeled 'Fire Escape.'" (Von Drehle, 2003: 215.)

Reform followed, with a change to the New York State constitution and then a new workers' compensation statute enacted, and a new building safety law and workplace protections.

> … two years after the Triangle fire, nearly every deficiency in the Asch Building [where the factory was on the upper floors] had been addressed. Automatic sprinklers were required in high-rise buildings. Fire drills were mandatory. Doors had to be unlocked and had to swing outward. Other new law enhanced protections for women and children and restricted manufacturing by poor families in their tenement apartment. To enforce the laws, the Factory Commission pushed through a complete reorganization of the estate Department of Labor.
>
> (Von Drehle, 2003: 215.)

RESOURCES FOR TEACHING

Excellent material with photos and interviews are available at Cornell University's Institute for Labor Relations website about the fire (https://trianglefire.ilr.cornell.edu/), other Cornell webpages (https://guides.library.cornell.edu/KheelDigitalCollections/TriangleFire), at the History channel (https://www.history.com/topics/early-20th-century-us/triangle-shirtwaist-fire), OSHA (https://www.osha.gov/aboutosha/40-years/trianglefactoryfire), and the American Society of Safety Engineers that was founded as a result of this tragedy (https://www.assp.org/news-and-articles/2017/03/24/asse-recognizes-anniversary-of-factory-fire-that-spurred-workplace-safety).

Accounts of the fire, the building's lack of safety, the prior fire losses of the owners of the Triangle Shirtwaist Factory at other companies, and the trial brought by the survivors, are provided in those website resources, and more extensively in two highly readable books about the fire, by Leon Stein, *The Triangle Fire* (2011) and David Von Drehle, *Triangle, The Fire that Changed America* (2003). A more academic historical perspective is by Arthur F. McEvoy's article, "The Triangle Shirtwaist Factory Fire of 1911: Social Change, Industrial Accidents, and the Evolution of Common-Sense Causality" (1995).

Issac Rubinow's book *Social Insurance* (1913) remains compelling, detailed, readable, and informative about the conditions of the Industrial Age that compelled the need for worker protections and for social protections through the various insurance mechanisms known as social insurance.

The treatise for particular coverage questions in cases is the multi-volume *Larson Workers Compensation Law*. This is immensely useful to understand how particular cases have been decided on particular topics, such as coming and going rules, traveling worker, at-home work, intoxication and drug use as being a factor (or not) in causing injury and therefore barring compensation. Cases can provide scenarios and guidance to illustrate how to critically think through coverage, and how courts can decide seemingly similar cases differently, which is important guidance for students to develop the thinking and analysis skill rather than the memorizing the answer that, say, a worker who had a beer and then is knocked over by another worker running down the hall, is

at fault and excluded from coverage.[24] In fact, some early cases dealt with alcohol on the job, when that was more common, and found that the use of alcohol was tolerated by the employer and therefore could not bar recovery.[25]

CURRENT ISSUES IN WORKERS' COMPENSATION FOR ENGAGEMENT

As stated at the beginning, workers compensation is an easy insurance policy to teach because of the simple coverage grant and few exclusions. Most claim disputes pertain to the facts of treatment and disability, resolved at the administrative level, thus few coverage cases make it to the courts. This is as it should be, to facilitate payment for work-related injuries without the need for lawsuits. The evolving nature of the work boundaries and the new recognition of long-term causes of injuries keep this old insurance coverage attractive, relevant and engaging for students. Here are some:

- The expansion of remote and at-home work has created more interesting questions of covered claims that enliven the topic: is tripping over the dog at home, being injured while getting something from the car at home, being burned by the coffee pot at home, sitting too long and developing an embolism, all within the scope of work? There are cases on these kinds of questions. Ohio is the first state to formally provide statutory guidance on at-home compensable injuries with its new law, Ohio House Bill number 447, effective September 23, 2022. The shift to service industries rather than factory labor has expanded questions of what was on the job injury. The cell phone and consequential work at all times of the day greatly expanded the range of times when a worker was working, for labor laws for overtime pay, and for compensable injuries.

- Presumption laws in various states have been enacted to deal with occupational diseases that result from exposure to toxic chemicals years earlier such as with firefighters, and skin cancer from work outside, and Covid.

- Marijuana for medical use is legal in many states, and remains illegal under federal law. Where a physician prescribes marijuana for medical conditions, should workers' compensation insurers pay for this? Should workers be allowed back on the job if they use prescribed marijuana and will that use be held against them in a subsequent injury?

Another way to use workers' compensation history is to bookend its historical past with the still somewhat contemporary Affordable Care Act as to challenges and controversies about government-control of insurance for medical treatment. In workers' compensation, the arguments were against paying for medical care for large swaths of the working population, and imposing responsibility upon workers for their own protection. These same arguments were made against the Affordable Care Act and why individuals and the market should solve the problem of the uninsured and uninsurable. The ACA has less relevance now than when enacted, but the connections can still be made that in this country every attempt to provide for medical protection is met with the same counterarguments of socialism and scaring off individual accountability. Another vector of relevance is how to provide the insurance mechanism for the medical care. Should there be a marketplace of private insurers, or a single-provider, or a tightly regulated market of private insurers as some European countries have for medical

[24] A New Mexico case decided that a garbage man holding on to the handrail on the side of the garbage truck and standing on the truck step to attach a grappler to the dumpster that fell in, would have fallen off anyway based on the narrowness of the step and the precarious movements, rather than caused by his alcohol level. villa v. City of Las Cruces, 148 N.M. 668 (2010)

[25] In these cases employees drank toxic chemicals that had been put by other workers into whiskey bottles usually kept on the premises, and the particular workers went to drink from those bottles, and because drinking on the job was tolerated the alcohol exclusion did not apply. Satchell v. Industrial Accident Commission of the State of California, 94 Cal.App.3d 473 (1949); Jakubowski v. Youngs, 278 A.D. 598 (App. Div. 1951); McCarthy v. Remington Rand, 275 A.D. 866 (1950).

care? These questions were presaged by the workers' compensation statutes in different ways in different states: in many states there are private workers compensation insurance, in some there is a state insurer of last resort, in some states there is a state insurer that competes with private insurers, and in a couple of states there is an exclusive state insurer. Thus, mandated coverage does not mandate a single insurer system. We do not have to repeat this debate about socialized medicine and individual responsibility. We had it over 100 years ago and came up with multiple solutions that still mostly, and of course never perfectly, work.

The lack of protections for gig-workers, independent contractors, and day-laborers can also be introduced, though this would work better within a lecture and presentation on all freedoms (for some employers and employees) and misclassification scams (by employers) of avoiding the panoply of tax and insurance benefits and obligations of being a W-2 employee.

CONCLUSION

Context to include history of why this coverage was enacted allows for a broader education on industrial labor history and why solutions must adapt and evolve to meet the situations, and to explore business practices and attitudes that left millions of workers dead and mutilated in the name of free labor and imaginary contracts. Black and white photos of dead people on the ground around the Triangle Shirtwaist Factory building are a visual grabber for classroom attention well beyond the insurance policy form. This creates relevance to thinking about why laws are enacted, why they are delayed, why insurance solutions can be elusive and then obvious, and how old solutions can be adapted to new problems. Besides that, the changing nature of work outside the former factory and office time-boundaries creates new questions for an old coverage. Just find a YouTube video of people walking into fountains and street signs while looking at a phone and then ask students to decide whether that injury would be a workers' comp claim if the text message written or read at the moment of inattentive impact was about work.

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What Is Mis-Happening Here? Connecting Loss Development, Reserving and Rate Indications

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Medical Mishaps Assurance, Inc. (MMA) is a group captive insurance company, specializing in medical malpractice (Med-Mal) liability. Headquartered in the metro Atlanta, Georgia area, its business is underwriting Med-Mal insurance for its members, which consist of physician practice groups, small hospitals and their affiliates across six southeastern states in the United States – Alabama, Georgia, Mississippi, North Carolina, South Carolina and Tennessee. Stacey Keeler, a member surgeon, represents the physician practice group members on the MMA Board of Directors.

It's after 9 P.M. on a Thursday, and Stacey just logged out of a Board call during which the Board selected Stacey to lead MMA's claims development, loss reserving and rate indication team for the next two years. Thinking over the Board meeting, Stacey sighs out loud. Despite being exhausted from a heavy week of surgeries and follow-ups, the surgeon is feeling pleased to have been entrusted with this effort. In the past, the Board has frequently disagreed with the reviewing actuary's opinion on claims development and reserves, and the final decisions by the Board regarding these numbers have had important implications for MMA's financial performance and the premiums charged to members.

Ultimately, Stacey's team is charged with determining the overall rate level indication for MMA. Too conservative a perspective on loss development can result in over-reserving, which can lead to rate indications that are unattractive to the membership (thereby possibly risking the loss of some members from the captive altogether). But too much of an emphasis on capital efficiency in loss development leads to under-reserving (reserve deficiency) and rate indications that later prove inadequate to cover future losses (and thereby possibly putting the captive's financial soundness at risk). Stacey's mind broadens to ruminate on the complexities of the Med-Mal environment.

MED-MAL LIABILITY INSURANCE CLAIMS TAIL

Med-Mal insurance can be written on an occurrence or claims-made basis; MMA writes occurrence-based policies. Moreover, new MMA members that are coming from expiring claims-made coverage may be provided with some limited tail coverage if they meet the underwriting guidelines (where tail coverage provides insurance against Med-Mal claims that arise after policy expiration for losses that occurred during the policy period).

Due to the long-tailed nature of Med-Mal liability and the likelihood of having a number of large losses in any given year, the claims data can be somewhat volatile. These factors can combine to make loss reserving and ratemaking decisions more complex than those used for personal automobile and homeowners. Incurred-but-not-reported (IBNR) claims can prove to be significant for a number of years after medical care was first provided. Once a claim is filed, quick response – both by the member and MMA – and appropriate claims management are critical to managing the financial impact. This can be difficult, especially in cases where the claim is filed long after the incident.

PAID VERSUS REPORTED LOSSES

Once a claim is reported and reserve is set, the claim may still take years to pay out. The reported losses are estimates (incurred loss reserves) at a given point in time. Final paid losses may be greater or less than the reported amounts. Even if reported losses could accurately estimate the ultimate amounts to be paid, the timing of payments may lag significantly behind the recognition of the incurred loss amounts for any number of reasons while a claim remains open.

MED-MAL INSURANCE LANDSCAPE AND MMA PERFORMANCE

The Med-Mal liability insurance market is marked in recent years by increasing premiums written, commensurate with overall increasing incurred losses. From 2007 through 2021, the Med-Mal market has seen Loss and Defense Cost Containment ratios[26] that hover generally in the 60-75 percent zone. During the same period of time, the number of Med-Mal insurers has increased in nearly every U.S. state.[27] This market has occasionally experienced times of crisis, leading to high prices for policyholders.

The 1990s, for instance, saw a competitive landscape dictated by: premium volatility; decrease in investments and investment returns; rapidly increasing loss ratios (due to increases in claims payments and DCC expenses); and growth of a large reserve deficiency. It was during this time that MMA was originally formed by a group of physician practices and small, rural hospitals in Alabama and Georgia. The charter group of MMA members sought premium stability and an improved ability to control underwriting and loss prevention.

MMA has grown steadily in the approximate 30 years since its formation, with much attention given to medical practice quality factors as key underwriting and loss control criteria. The group captive has enjoyed a surplus in every year of operation, and in three years a large enough surplus that the Board decided it warranted partial premium refunds to members.

ANALYSIS

On Friday morning, Stacey continues to think through the critical role that the loss reserving team will play in coming years. An email notifier pops up on the computer screen, indicating a message from a MMA email address. Opening the email, Stacey reads,

"Good morning, Dr. Keeler. Thank you for your willingness to lead the loss reserving team. Kindly find attached several Excel-based exhibits that show our claims counts in recent years, as well as reported and paid losses during those same years. The reviewing actuary has provided templates for developing losses, determining loss-adjustment expenses and selecting a rate level indication. After you have reviewed, let me know if you have any questions. We are behind schedule to make a rate determination, so the quicker your team can analyze and come to a recommendation the better.

Sincerely,

Jo Dooley, MMA Claims Director"

Stacey will have to let the exhibits wait until the weekend. The dashboard calendar serves as a quick reminder that today's schedule includes two major surgeries and four surgical follow-up visits. Stacey and team have been given all the financial information available to make a judgment regarding rate level indication:

[26] The "Loss + DCC Ratio" is calculated as (direct losses incurred + direct defense and cost containment expense incurred)/direct premiums earned.

[27] These data are taken from the *Countrywide Summary of Medical Professional Liability Insurance, 2007-2021* published by the National Association of Insurance Commissioners, June, 2022.

Loss Development Exhibit 1 (worksheet *Loss Dev Ex. 1*): Shows paid losses based on the most recent 10 years of calendar-accident year experience evaluated as of September 30 (21 months after the start of Loss Year), and requires calculation of paid loss development factors and estimation of ultimate loss development factors;

Loss Development Exhibit 2 (worksheet *Loss Dev Ex. 2*): Shows reported losses based on the most recent 10 years of calendar-accident year experience evaluated as of September 30 (21 months after the start of Loss Year), and requires calculation of reported loss development factors and estimation of ultimate loss development factors;

Loss Development Exhibit 3 (worksheet *Loss Dev Ex. 3*): Shows claims counts based on the most recent 10 years of calendar-accident year experience evaluated as of September 30 (21 months after the start of Loss Year), and requires calculation of claims count loss development factors and estimation of ultimate loss development factors;

Loss Development Exhibit 4 (worksheet *Loss Dev Ex. 4*): Estimation of ultimate losses based on data from LD Exhibits 1-3;

Expense & ULAE Exhibit 1 (worksheet *Exp & ULAS Ratio Ex. 1*): Derivation of the unallocated loss adjustment expense (ULAE) ratio;

Expense & ULAE Exhibit 2 (worksheet *Exp & ULAS Ratio Ex. 2*): Selection of the expense (including ULAE) provision using the all-variable projection method; and

Loss Ratio Indicated Rate Exhibit (worksheet *Loss Ratio Indic Rate Ex.*): The final determination of the indicated rate change, based on data from the other exhibits, externally-provided data and professional judgment.

ASSIGNMENT

You have been asked by Stacey as a trusted team member to take a first stab at determination of the indicated rate change for MMA. Based on the information provided in the case as well as in the exhibits, respond to the questions below.

Question 1

Using the Excel-based Loss Development Exhibits 1, 2 & 3 (see worksheets *Loss Dev Ex. 1, 2, & 3*), calculate loss development factors (**LDFs**), select LDFs for further loss development, and calculate the resulting ultimate LDFs for: a) paid losses; b) reported losses; and c) claims counts. Make specific recommendations, assuming no other relevant decision factors. Given the calculated LDFs and the actuarially-weighted LDFs, justify to Stacey your recommendations for your selected LDFs (in Loss Development Exhibits 1-3) and your selected ultimate losses (in Loss Development Exhibit 4 in worksheet *Loss Dev Ex. 4*).

Question 2

Using the Excel-based Expense & ULAE Ratio Exhibits 1 & 2 (see worksheets *Exp & ULAE Ratio Ex. 1 & 2*), calculate / select the appropriate ULAE ratio and the expense (including ULAE) provision for ratemaking purposes. Given the calculated ratios, justify to Stacey your recommendations for your selected ULAE and Expense & ULAE ratios.

Question 3

Using the Excel-based Loss Ratio Indicated Rate Change Exhibit (see worksheet *Loss Ratio Indic Rate Ex.*), make a recommendation as to the indicated rate change for MMA in the next year. Justify your recommendation to Stacey, given the data that are available.

Question 4

Reconsider your recommendation in Question 3 in light of the current Med-Mal market conditions and trends in the environment for the group captive.

Question 5
Referring back to your work in response to Question 1, if you change your selection for LDFs related to paid losses, reported losses and/or claims count, how sensitive are your ultimate losses to the change(s)? How sensitive is your indicated rate level change to the change(s)? What does this tell you about the importance of appropriate loss development and reserving to determining appropriate rate changes?

For the assignment, assume all policies are annual and the proposed effective date of the rate change in North Carolina is January 1st of each year, and rates are expected to be in effect for one year. Begin with the loss triangles in Loss Development Exhibits 1-3 and use those Exhibits to complete Loss Development Exhibit 4, then switch over to complete Expense & ULAE Ratio Exhibits 1-2. From there, you can complete the Loss Ratio Indicated Rate Exhibit.

TEACHING NOTE

This case is based on a fictitious, medical malpractice (Med-Mal) liability captive insurer – Medical Mishaps Assurance, Inc. (MMA) – and its loss reserving and ratemaking considerations and needs. Liability insurers face a variety of challenges. The Med-Mal liability insurance segment faces some additional risks that are unique to the segment. The captive insurers within this segment hold some advantages over their profit-seeking competitors since they exist to serve the policyholder-members without the pressure to maximize the captive's income, cash flows or net wealth position. There are disadvantages as well, not the least of which in the case of MMA is its lack of diversification. Its financial survival and performance rest on the quality / performance of its Med-Mal business operations.

MMA's ability to appropriately develop losses, set loss reserves and make rate determinations depends upon a variety of factors, including data availability, analytics and attention to the prevailing claims and expense trends. The consequences of failing to meet these challenges could include under- or over-reserving and premium volatility. Group captives such as MMA also have a responsibility to be conservative and risk averse, given they answer to their policyholder-members.

The simplicity of the business story and the required spreadsheet work make the case appropriate for undergraduate risk management and insurance students, while the strategic risk management application makes the case appealing to graduate students as well. Both student groups benefit from thinking strategically about a business problem that at first glance appears to be strictly mathematical. The themes in the case are suitable for courses in insurance operations, commercial liability insurance, alternative risk financing and business risk management. The case is best used after students have been introduced to insurance company operations, most particularly the general business model, loss development, loss reserving and base ratemaking methods (e.g., pure premium and loss ratio methods).

Student Learning Objectives
Students completing this case will be able to:
(1) Calculate age-to-age loss development factors and ultimate loss development factors;
(2) Select reasonable and appropriate loss development factors;
(3) Calculate ultimate loss estimates;
(3) Appreciate the factors that impact loss development and loss reserving;
(4) Calculate the expense provision that goes into ratemaking;
(5) Calculate an indicated rate level change using the loss ratio method;
(6) Consider the claims development, loss reserving and ratemaking implications of claims trends and market conditions; and
(7) Recognize the interconnectedness of claims development, loss reserving and ratemaking.

Suggested Readings

The Institutes (2022). *CPCU 520: Connecting the Business of Insurance Operations*: Assignments 6 and 7.

Insurance Information Institute website (Current as of 2022 November). "Understanding medical malpractice insurance." https://www.iii.org/article/understanding-medical-malpractice-insurance

National Association of Insurance Commissioners (2022). *Countrywide summary of medical professional liability insurance 2007-2021*, Center for Insurance Policy and Research Library. https://naic.soutronglobal.net/Portal/Public/en-GB/RecordView/Index/25359

A Note On The Loss Development Method Used

The case exhibits utilize the chain ladder method. The expected loss ratio method and/or Bornhuetter-Ferguson method could be used in addition to (or in lieu of) this method. Chain ladder method estimates incurred but not yet reported (IBNR) losses. It assumes the cumulative claims loss settlement factor (loss development factor) for a specific development year is based on past development experience. Bornhuetter-Ferguson method also estimates incurred but not yet reported (IBNR) losses. It combines the chain ladder and expected loss ratio methods and assigns weights for the percentage of losses paid and losses incurred. Unlike the chain ladder method, the B-F technique builds a model based on the insurer's exposure to loss.

Suggestions For Use

The case exhibits and solutions are available at: https://docs.google.com/spreadsheets/d/1o_aUG8hK2dbQOxO365sYGb55lhXYSajf/edit#gid=2065406726There are two possible approaches to this case, depending on the emphasis the instructor wishes to place on the case and the background of the students.

Undergraduate classes: Students should come to class having read the case. The class period can focus on Questions 1-2 and discussion of student recommendations. It may also be possible to have a discussion of other qualitative factors, including risk (especially as relates to Questions 3-4). The instructor may choose to assign Questions 3 and 4 as a take home assignment to be completed in teams or individually.

Graduate classes: Students may be required to come to class with a completed model for all four questions and having read the suggested readings cited above. This allows the instructor to focus on a higher-level discussion of risk management, as well as other qualitative factors that might impact the choice of base rate change and/or may stretch students to think beyond the base rate to individual member pricing considerations.

As planning guidance for the instructor, time estimates for all steps of the process are given below. The instructor may eliminate, abbreviate, or expand any of these steps to suit classroom objectives and needs.

1. Introduce the case and have students read through the text of the case. (20 minutes)
2. Provide the appropriate Excel template (exhibits) based on the student level. Have students work in pairs to complete the basic calculations required. (30 minutes)
3. Review estimates with the students and discuss the "selected" values judgment process. (10 minutes)
4. Have students work in pairs to complete the selection of final values in the exhibits and the final rate indication recommendation. (20 minutes)
5. Form pairs into teams of four and assign teams to bullet point one additional decision criterion to be considered. (10 minutes)

6. Teams report on their recommendations, with class discussion. (30 minutes)
7. Summarize the case, point out learning outcomes, and share concluding thoughts with students. (15 minutes)

Data Flexibility

Because instructors may differ from one another with respect to detailed learning objectives, and any/all instructors may desire different initial values to present to different classes (or even within classes to different pairs), the authors provide a "gen data" worksheet within which the instructor can generate new loss data:

- Claims counts can be generated based on either a Poisson or normally-distributed random process.
- Reported (incurred) losses can be generated based on either an exponential or normally-distributed random process.
- Paid losses can be generated based on either a generous, moderate or conservative payment profile, given the claims count and reported losses.

Before releasing the Excel file to students, instructors should consider deleting the worksheet *gen data* to prevent students from inadvertently changing the historical data in Loss Development Exhibits 1, 2 & 3. Alternatively, the VBA program used to generate the simulated data can be disabled by saving the file as a standard xlsx Excel file.

SUGGESTED SOLUTIONS TO ASSIGNMENT QUESTIONS

You have been asked by Stacey as a trusted team member to take a first stab at determination of the indicated rate change for MMA. Based on the information provided in the case as well as in the exhibits, respond to the questions below.

Question 1: Loss Development

Using the Excel-based Loss Development Exhibits 1, 2 & 3, calculate loss development factors (LDFs), select LDFs for further loss development, and calculate the resulting ultimate LDFs for a) paid losses; b) reported losses, and c) claims counts. Make specific recommendations, assuming no other relevant decision factors. Given the calculated LDFs and the actuarially-weighted LDFs, justify to Stacey your recommendations for your selected LDFs (in LD Exhibits 1-3) and your selected ultimate losses (in LD Exhibit 4).

Question 2: Expense & ULAE Provision

Using the Excel-based Expense & ULAE Ratio Exhibits 1 & 2, calculate / select the appropriate ULAE ratio and the expense (including ULAE) provision for ratemaking purposes. Given the calculated ratios, justify to Stacey your recommendations for your selected ULAE and Expense & ULAE ratios.

The assignment difficulty for Questions 1 and 2 can easily be varied by providing an Excel template with more or less information provided. The Excel file available with this case contains key formulas that automatically populate many of the cells. The instructor has the flexibility to decide whether and which formulas to provide in the file worksheets.

Intermediate Assignment Level: This level is appropriate for intermediate level undergraduates with Excel skills and basic knowledge of loss development and base rating methods. The provided template provides the format and labels, but students must complete all the calculations as well as make realistic assumptions about trends and market conditions.

Advanced Assignment Level: This level is appropriate for more advanced undergraduate students and graduate students. Students are required to design an Excel solution given only the most basic information (initial loss triangles and other "givens"). Most pairs will require more than 30 minutes to complete the calculations, so this level should only be used if the assignment can be stretched across multiple class periods or be completed outside of class.

Solution Notes for All Levels: For all levels of the assignment, instructors can choose whether or not to require formulas, use of absolute cell references when appropriate, formatting, and so on. When the case is used in

person (not as a homework or other outside-of-class project), the authors have found that students complete the calculations and/or formulas more easily and quickly when working in pairs rather than larger teams.

Question 3: Loss-Ratio-Based Rate Change Indication

Using the Excel-based Loss Ratio Indicated Rate Change Exhibit, make a recommendation as to the indicated rate change for MMA in the next year. Justify your recommendation to Stacey, given the data that are available.

The assignment difficulty for Question 3 is relatively low, given that information from Questions 1-2 feeds the process of determining an appropriate response to Question 3.

Question 4: Consideration of Market Conditions

Reconsider your recommendations in Questions 1-3 in light of the current Med-Mal market conditions and trends in the environment for the group captive.

This question should prompt a discussion of assumptions regarding market cycles, the dangers of over- and/or under-reserving, the time value of money, loss control and other factors that can be expected to impact a captive insurer's performance.

Students who have business experience are likely to think of more items than those who are inexperienced, and these items may be more thoughtful / complex than those considered by inexperienced students. Perhaps the most important part of this assignment question is for students to use their imaginations and see "all" possibilities.

Question 5: Sensitivity Analysis

Referring back to your work in response to Question 1, if you change your selection for LDFs related to paid losses, reported losses and/or claims count, how sensitive are your ultimate losses to the change(s)? How sensitive is your indicated rate level change to the change(s)? What does this tell you about the importance of appropriate loss development and reserving to determining appropriate rate changes?

This question should prompt a critical thinking about the interconnectedness of claims development, loss reserving and rate level change indication. Students who systematically make adjustment to one selection (upward/downward) at a time, in isolation, will see the connectedness most clearly. Perhaps the most important part of this assignment question is for students to be methodical so that relationships reveal themselves in patterns of sensitivity between and among variables.

EFFICACY IN THE CLASSROOM

The authors assert the case can be used successfully with both undergraduate and graduate business students. For Questions 1-3, all the necessary information is contained in the case and assignment materials; no outside resources are needed. Question 4 requires thinking beyond the case materials per se, but does not necessarily require additional research on the student's part.

As mentioned previously, the case can generate multiple rich discussions, not the least of which is the importance of considering all relevant criteria possible in decision making, even those criteria which are futuristic and/or difficulty to quantify. The case also provides an opportunity for students to see that assumptions made by decision makers can alter the findings and recommendations. Some students may initially struggle with setting up/designing the spreadsheet because the information does not fit neatly into one template design.

One of the authors has utilized various versions of the case over a period of eight consecutive semesters in an undergraduate (senior-level) insurance operations course. Using a combination of direct feedback from students as well as student performance / success in completing the case assignment has been employed during this approximate four-year testing period. The current case version is responsive to feedback received.

MS Excel workbook for this case is found at:
https://docs.google.com/spreadsheets/d/1o_aUG8hK2dbQOxO365sYGb55lhXYSajf/edit#gid=2065406726