

"Tell me and I forget, teach me and I may remember, involve me and I learn."

— Benjamin Franklin

1. **Alla Kammerdiner**, Industrial Engineering; Office: EC3 286, (575) 646-2475, alla@nmsu.edu; I will attend the Gala
2. I love learning, and I seek to make learning a richer, more joyful experience for my students. Since the Spring of 2014 I have been teaching IE451 (Engineering Economy) via the innovative paradigm of **game-based learning (GBL)**. I chose this method as I want students to enjoy learning, to take greater responsibility for their own and their peers learning, and to acquire tangible experience and practical skills. Traditional pedagogy that relies on textbook examples and exercises is poorly suited to accomplish this. Yet, it is most often used to teach engineering economy.

A new generation of learners known as Digital Natives (Prensky, 2001) have a distinct cognitive style. They desire to play, see a payoff, be connected, active, and use fantasy. The needs of this new type of learners call for different, non-traditional teaching, and GBL suits their needs. When discussing the evidence on effectiveness of GBL, Tobias, Fletcher, and Wind (2014) write that "few instructional methods engage similar level of interest among learners or induce them to persist on tasks for as long as games do."

I argue that **well-designed games** can enrich college experience and support learning. In fact, most Gen X, Millennial, and Gen Z students have grown up playing games and many continue to play. Gamification is used increasingly by many successful businesses for training, collaboration, and better performance. Children learn through play. Play can also be great for learning of college students, as my experience using a serious game in IE 451 shows.

GBL or serious gaming is the use of game principles for the purposes of learning, skill acquisition, and training. A body of empirical evidence on the effectiveness of using serious games for instruction is rapidly growing, and higher education is beginning to incorporate serious gaming into curricula. Many **benefits of GBL** include

- high student motivation with increased time on task, and more meaningful feedback,
- greater engagement, and augmented learner-learner and learner-content interaction,
- ability to learn from mistakes without real-life consequences and without becoming discouraged,
- and potential for behavior and attitude change.

To apply GBL to my course, I completely redesigned it into a semester-long game. **The game empowers engineering students to get fully involved and experience economic decision-making together** with their teammates and classmates. They start split into eight teams with an equal amount of virtual money and a goal of maximizing their wealth by the end of the game/semester. To manage these funds, students use the ideas and methods of engineering economics that are learned during the course. The winners of the game receive an A in the course regardless the rest of their grades. This rule serves as a powerful incentive for all my IE 451 students. I have taught IE 451 using GBL twice (in Spring 2014 and again in Spring 2015). So far, the rule was applied only twice to raise the course grade from a B+ to an A with the majority (eight out of ten) winners on the two winning teams already having an A.

The game design and implementation are largely inspired by backward course design, quality matters rubrics, writing across curriculum, team-based learning, and active learning. The game is played in twenty turns, which align with the key learning objectives, outcomes, and competencies. According to **backwards course design**, I redesigned IE 451 with a focus on activities that my students should be able to *do* by the completion of my course. For example, they must be able to interpret the situation and data, formulate proper alternatives, and use the suitable analysis techniques to select the best alternative. The turns allow students a chance to practice economic decision-making using various analysis techniques, starting with simpler ones (e.g., single-payment factors) and ending with more complex (e.g., uncertainty). Another instance is determining quantities to breakeven and to maximize the profit.

Traditional textbook and example based instruction oversimplifies these tasks and does not provide the **high level of fidelity with which the game approximates the reality**. The decisions that students make each turn have

tangible consequences on the changes in their wealth and ultimately on the end-result of the game. Valuable life lessons can be learned from both mistakes and successes. Seeking to acquire more assets some teams tend to borrow too much and pay a high interest rate. Other times teams could make risky decisions that may or may not pay off. Wrong decisions could be costly in real life. Game provides a safe way to experiment and learn from mistakes.

As in **team-based learning**, students are assigned to permanent teams and their grades are based on their performance on individual and team tasks. Teammates are accountable for contributing to the team via a sequence of teamwork surveys. Teams work on the game assignments in class and outside of class. The game is designed to encourage interaction among teams. Teams are able to successfully complete tasks, which can be too challenging for most students on their own. By discussing the solutions to these complex problems, students are able to attain deeper levels of learning.

IE 451 is a senior course. **To meet employers expectations**, I help my students develop their abilities to make a persuasive argument, problem solve, think critically, work with people from diverse back-grounds, and work on a team. During the game teams can acquire various assets (bonds, mines, factories, ships, etc.), manage their current assets (manufacture things in their factories, mine ores in their mines, etc.), trade with other teams, lend money to other teams, borrow money from the bank or other teams. Based on available information each turn, teams have to make their decision, document it in the economic decision file, and update their expenses and revenues in the financial report file. I provide template files, instructions, and rubrics. In the financial file (MS Excel), they perform computations, and keep track of their capital and produced items. In the decision file (MS Word), they concisely state their decision for the turn, show their use of economic analysis principles, and clearly explain their reasoning. Thus, students regularly practice written and oral communication skills.

The use of serious gaming in my course is incorporated into a **broader instructional system** that includes flipped classroom with YouTube videos, rich Canvas content, in-class interactive examples, and three comprehensive exams. YouTube videos allow students to have on-demand access to new course material. Canvas learning management system is used to run the game, with the homepage displaying the teams and their accumulated assets (as icons) along with the rules of the game. Each time the team acquires a new asset a corresponding icon is placed into the team's quadrant. In class I use interactive examples to highlight the difficult concepts and misconceptions as well as to probe student understanding of the methods. Exams are individual assessments that allow each student to evaluate personal achievement of learning outcomes.

3. My GBL innovation has been enabled by the NMSU Teaching Academy. Typically for many engineering educators, I have not received any formal training in education. To fill this gap, I engage in professional development of teaching. I have been a Distinguished Member of the Teaching Academy every year since joining NMSU in the Fall of 2010. Moreover, I was the 2012 Most Distinguished Faculty Member. **The following workshops have been formative for my implementation of GBL.** I completed "Team-Based Learning" workshop on 6/10/2011. I participated in "Jump Starting Active Learning" by Michele Nishiguchi & Ralph Preszler in 2/2/2012. I also attended "Flipping your Classroom: Going beyond the Walls of the Classroom" on 4/4/2013, and "Engaging Millennial Learners" by Christy Price on 9/26/2013. I took "Writing, Teaching, and Learning across the Curriculum" in 2012, 2013, and 2015. Through my involvement in Online Course Improvement Program in 2011-2012, I learned about backward course design and how to apply the quality matters rubrics for designing online/blended courses. Finally, I gave **my talk "Design A Game-Based Course to Engage Your Students"** at the Teaching Academy on 03/30/2015. My presentation was well received.

4. Involving students into the game had a significant positive impact on student attitude, motivation, and learning. Multiple forms of evidence strongly support this statement.

Peer-Assessment: My Spring 2015 IE 451 was visited by Dr. David Smith. He told me my students were enthusiastic about the game. The game and team tasks got a positive peer feedback during "Assignment Design Symposium" on 3/4.

Student Course Evaluations: After the introduction of GBL, many students wrote that the instructor's greatest contribution to the course was “creating the game as a fun alternative to class work/homework” and “as a fun way to learn economics.” Additional characteristic comments about the game include:

“The game really is a neat idea to encourage practice of the concepts in a real-world perspective... it really was an exciting challenge to analyze the data and try to out-manuever the other teams.” ☺ “I enjoyed the "game" that was played throughout the semester.” ☺ “The Game was the best tool to effectively nail the economics and financial knowledge in our minds.” ☺ “I believe that the game we played throughout the semester was very effective because we were using what we were using in class for real life applications.”

The new tools introduced to support the game, such as YouTube demonstrations and interactive examples have been also effective as evident from the following student comments:

“She went out of her way to make two youtube videos ... The youtube videos were long and in great detail and must have taken a significant amount of her personal time to create. This kind of dedication is very valuable...” ☺ “Explained examples really well! Didn't even have to read the chapter ahead of time because I retained it all in class. That's a nice thing to be able to do. Doesn't happen in a lot of classes.” ☺ “She truly cared about if the students were learning the material or not and wanted us to succeed in her course.”

After introducing the game, the entire course is perceived more positively (e.g., see a sample comment below:

“I think this class was very good and interesting. I feel that the material is very relevant to many things in my life and in my future. The content was very relevant. The classes taught me a lot.”)

The positive impact is evident from the increase in means for Questions A – D from Before GBL to After GBL.

Comparison of student responses on course evaluations of my IE 451 course before and after implementing GBL:

Survey Questions * (1) strongly disagree, (2) disagree, (3) neutral, (4) agree, (5) strongly agree ** (5) very easy, (4) easy, (3) about right, (2) difficult, (1)very difficult	Mean Before	Mean After	
	2012	2014	2015
A. Instructor related course content to practical applications/design: *	3.51	3.80	4.13
B. The objectives agreed with what was accomplished during the semester: *	3.68	4.04	4.00
C. I gained new knowledge and skills that I feel will be useful in other courses: *	3.59	3.76	3.96
D. Instructor promoted critical thinking & problem-solving skills: *	3.56	3.88	3.75
E. For my preparation and ability, the level of difficulty of this course was: **	3.32	3.04	3.29

Grade Performance: Note that Question E above shows that IE 451 is perceived **as difficult or harder after introducing the game**. Despite this, the grade distribution of IE 451 students has been improved dramatically with 99% As and Bs! I argue that my students are more involved and as a result they are able to learn more (see quote on the top).

Percentage of each grade earned by my IE 451 students before and after implementing GBL:

Grades	% before	% after
A	32	73
B	37	26
C	18	0
D	8	0
F	3	0
W	2	1
Number of students	94	80

The Accreditation Board for Engineering and Technology (ABET) Assessment of Learning: The ABET data below measures the Program Learning Outcomes. The figures support the key improvement in achieving learning outcome:

Before GBL: Spring 2011 – 79.25% and **65.38%** (the last outcome is not met) on Instruments 1,2.

After GBL: Spring 2014 – 81.82% and 78.26% on Instruments 1,2 (both outcomes are now met).

Fernando Herrera
PO Box 4071
Las Cruces, NM 88003

March 2, 2015

To whom it may concern:

I am pleased to recommend Dr. Alla Kammerdiner's Simulation Game for our Engineering Economy class. This is the first time I have taken a class in which a game is played throughout the semester which focuses on the principals of the subject being taught.

The way this game is played simulates industries and their responsibilities to make sound economic decisions in order to benefit themselves. The class is broken up into several teams, and each team would consist of several students put together at random. Each of these teams represent an entity with a starting balance and every team has the opportunity in purchasing mines, factories, bonds, materials, warehouses etc. from either by auction or by direct sale. Once a team acquires an asset, they now have to use that asset to where it benefits them. The team with the most money available at the end of the semester wins.

The duration of the game is divided up into turns, which represent a calendar year. At the end of each turn, each team is required to generate a report as to why they're doing what they're doing. Each turn corresponds to the lectures and sections of the text book being taught at that time, so an analysis incorporating with what is being taught is also required in the report being turned in. The way the students are graded is not by their performance or standings in the game itself, but by the reports being submitted.

One of the reasons I am recommending this game is because it does something different rather than reading situations from the book; it creates situations where students would have to think and process in order to survive. There is a big difference between reading an example if company x needing to decide whether to make 50 or 100 widgets and having to decide how many widgets would maximize profit with different variables in an ecosystem which involves competition from other teams and fluctuating prices of raw materials. I like this game because it does simulate what goes on in the real world not by simply observing what industry does, but by empowering the classroom to make their own decisions and the opportunity to convert mistakes made into lessons learned.

Sincerely,



Fernando Herrera

To Whom It May Concern,

I have been ever so privileged to have Alla Kammerdiner as a professor. The enthusiasm Dr. Kammerdiner has for teaching is mirrored only by her full scope of knowledge for the subject of engineering economics. Dr. Kammerdiner possesses the ability to spark enthusiasm in all students. There are few professors that are able to engage their students like Dr. Kammerdiner does. Although many engineering topics tend to be mundane and monotonous, Dr. Kammerdiner's teaching encourages students to broaden their minds. Learning from Dr. Kammerdiner has been an advantage in many aspects.

Throughout the 2015 Spring semester, Dr. Kammerdiner has assigned a team engineering economics game. Initially the game seemed overwhelming and intense. The amount of turns throughout the semester and the work required per turn came off as quite daunting. Each economic decision mandated adequate studying of the material as well as communication with team members. Not only did the workload pile up quickly, but an understanding of the game came only with time.

Overall, I admit that this engineering economics game has vastly deepened my understanding for the topic of engineering economics. Not only has the material become more applicable, but working as a team has encouraged me to increase my communication skills. This engineering economic game gives the class a common goal while encouraging a respectable amount of competitiveness. Making engineering economics into a friendly designed game was a wonderful idea. Engineering economics is not an especially easy topic, nor does it come off as simple, but this game creates a new vision for what engineering economics could be.

Please contact me for any further information,

Julia Morgan



Mechanical Engineering Technology
New Mexico State University
julcmor@nmsu.edu
575-921-3716

March 2, 2015

IE 451 – Dr. Kammerdiner – Engineering Economy Game Review

The following is a review of the incorporation of the engineering economy game used in IE 451, Engineering Economics, at NMSU, from the perspective of a current student.

The game is very helpful to me in applying some of the concepts we learn in class to a more “real-world” simulated problem. Each turn parallels with what we are learning in class, and helps emphasize some basic concepts of engineering economics, like cash flow diagrams, interest rates, and calculating net present worth, for example. The idea of competing with other teams is also beneficial because in the real world, there will always be some competition. Having to base decisions off of the uncertainties of what other teams are doing is difficult, which makes the game more involved and interesting. Having to analyze each opportunity is also more of how companies decide things. It is not always a simple calculation given in a textbook, because many variables have to be taken into consideration. Textbook problems don’t always emphasize that, so this game is helpful in building decision making skills, where these decisions will have an impact on our success in making profits throughout the game.

This game is also useful outside of this class. We are assigned into groups at the beginning of class, and are to work with our teams throughout the semester for the entire game. Working in teams is essential to all fields and degrees, and this game is just another experience to build those skills. It helps me learn how to discuss and respectfully debate ideas with my teammates about our decisions. It also provides the opportunity to hear other team member’s ideas, some I may not have even thought of. Many employers value this skill of being able to work in a team.

The only recommendation I would make to the game, is to have the auctions be held more like an actual auction. The way it is played now, seems like a silent auction, where we submit our bids and hope we are the highest bidder. Perhaps we could do the auction during class, and each team could bid against each other then, or if there is some way to do that in an online discussion of some sort, I think that would simulate more of an auction that what is currently done.

Overall, I would recommend this course and the incorporation of the game into future courses because I think it really gets students involved in the class. It’s more fun than typical homework assignments with the additional benefit of meeting new people, while also forming more concrete understandings of concepts taught in class.

Lindsey Skowlund

