

The economics of online dating: a course in economic modeling

Andrew J. Monaco
Assistant Professor of Economics
University of Puget Sound
McIntyre Hall 213H
1500 N. Warner St., Tacoma, WA 98416

amonaco@pugetsound.edu
253.879.3591 (telephone)
253.879.3556 (fax)

The economics of online dating: a course in economic modeling

Abstract

I discuss the development of a unique course, The Economics of Online Dating. The course is an upper-level undergraduate course which combines intensive discussion, peer review, and economic theory to teach modeling skills to undergraduates. The course uses the framework of “online dating,” interpreted broadly, as a point of entry, via Paul Oyer’s popular economics book *Everything I Ever Needed to Know About Economics I Learned from Online Dating*. I then explore an approach to teaching students how to not just *solve* models, but to *create* economic models from abstract ideas. This approach to teaching modeling is supported by Albert Bandura’s work on self-efficacy as a bedrock pedagogical principle.

Keywords: microeconomics, economic theory, economic modeling, applied microeconomics, game theory, matching markets, dating markets, peer review, self-efficacy

JEL Codes: A12, A22, D00

Date last revised: 6/19/2017

In theory courses - whether in economics or in other disciplines - theory becomes an object of study. Professors teach about theory - because this is how they were taught, because this is how textbooks are organized, and because it's relatively easy to teach students how to step up and solve a series of standard models. But to teach students how to do theory? It's like riding a [bicycle] - ultimately, the only way to learn is just to push off and start peddling. Send people off to model the world and see what they come up with.

-Frances Woolley, Carleton University, on the economics blog *Worthwhile Canadian Initiative*, July 20, 2014;

Paul Oyer's 2014 book *Everything I Ever Needed to Know About Economics I Learned from Online Dating* is the ideal pop econ book. Oyer uses his experience in the dating market to highlight the explanatory power of core ideas in economic theory: adverse selection, search theory, cheap talk, network externalities, matching markets, and others. In Chapter 4, for example, Oyer discusses signaling and highlights a key theoretical result: signaling must be sufficiently costly to some of the signal senders in order to be credible. He draws a connection between costly signaling in the job market, such as the American Economic Association's "private signal" program for economics Ph.D. job applicants, and a Korean dating website which solved its credibility problem by giving each user two "virtual roses" which could be sent along with a date request. Since each user has only two to give, sending a rose is costly to the sender, and receiving a rose along with a date request sends a strong and credible signal of interest.

A reader of Oyer explores parallels between dating markets and many other markets, developing a deceptively deep understanding of profound, and often quite technical, economic

theoretical results in the process. I create a course to live in that space, between the accessible topic of online dating and the complex and powerful results in many areas of (micro)economic theory. Online dating serves as an alluring point of entry, but ultimately, the course is an advanced undergraduate microeconomic theory course with a focus on economic modeling.¹

The course is **The economics of online dating**, an upper-level undergraduate course with introductory economics as its only prerequisite. One colleague has described it as “a Trojan Horse into the world of economic model-making,” and another has said that although it “may simply sound like a sexy course ... it is theoretically rich and complex, wherein on-line dating is used as a vehicle to explain and develop other models of economic phenomena.” The course loosely follows the progression of theoretical topics in Oyer’s *Everything I Learned*, with modules (Figure 1) built to scaffold students’ theoretical background and modeling experience. Each module in the course is structured as an iteration of three stages where, at the end of each iteration, students construct a model. As the course progresses, the theory grows more complex, and provides students with an increasingly flexible set of tools with which to build models. By semester’s end, students will have strengthened their background in economic theory, built economic models across a range of topics, and cultivated agency and confidence in analyzing everyday phenomena with the precision of economic modeling.

I begin with a pedagogical rationale for the course which relies on the concept of self-efficacy. I then provide an exposition of the three stage progression for each module, implementation strategies, and evidence of effectiveness of the course.

¹ It is always fascinating to meet the parents of a student who has taken the course at graduation. “This is the professor who teaches the online dating course!” they explain, before I must then absolve myself of any responsibility for their son’s or daughter’s current dating status.

Unit Title (Relevant Chapter(s) in Oyer)	Additional Readings	Fundamental Theory learned in this unit includes:	Models students build
Individual Choice (Chapter 1: Search Theory)	<ul style="list-style-type: none"> •Whitman, Ch. 1 •Slater, Ch. 1 •Whelan, p. 6-12 •fivethirtyeight video 	utility, rationality, marginal utility, risk, probability, expected utility	Model #1: decision under risk Model #2: search theory
Game Theory (Chapter 2: Cheap Talk)	<ul style="list-style-type: none"> •Talwalkar article •Wallace article (WSJ) •Barclay article (Vox) 	game theory, static games, best responses, Nash equilibrium, incomplete information I, dynamic games, subgame perfection	Model #3: static game model Model #4: dynamic game model
Networks (Chapter 3: Network Externalities)	<ul style="list-style-type: none"> •Landsburg, Intro and Ch. 1 	driving networks and Braess' Paradox, first-mover advantages, network externalities and demand	
Signaling vs. Cheap Talk (Chapter 4: Signaling; Chapter 5: Statistical Discrimination; Chapter 7: Adverse Selection)	<ul style="list-style-type: none"> •Whelan, Ch. 5 •Bobrinskoy video •Golden Balls video •Talwalkar article 	incomplete information 2, information sets	Model #5: signaling or cheap talk model
Matching (Chapter 6: Thick Versus Thin Markets; Chapter 8: Positive Assortative Mating)	<ul style="list-style-type: none"> •Harford, Ch. 3 •Talwalkar article on Gale-Shap •Webb video •Nelson article (Vox) 	matching markets: one-sided, two-sided, one-to-one, many-to-one, deferred acceptance, stable matching, deception	Model #6: matching model
(Chapter 9: The Returns to Skills; Chapter 10: The Family)		social choice rules, Arrow Impossibility Theorem, probabilistic threats/brinksmanship, bargaining	Model #7: student's choice (time permitting)

Figure 1: All 6 units of The Economics of Online Dating. Considerable time is spent on the first two units, as they are the most fundamental. The last unit is easily condensed given time constraints.

Pedagogical Motivation

Undergraduate economic theory typically centers on students learning the mechanics of models introduced by the instructor: the IS-LM model, the utility maximizing consumer, the Bertrand duopoly, and countless others. The instructor presents the fundamentals of the model (agents, payoffs, market mechanisms, prices), and students learn the model through a combination of demonstration (seeing the model solved) and experience (solving for the solution or equilibrium of the model in exercises.)

An economist understands her model is a representation of some real world phenomenon, relying on a collection of assumptions to arrive at a result *conditional on those assumptions*. Assumptions are therefore pillars of economic models. Gilboa et al. (2011) describe this approach as **case-based reasoning** or **analogical thinking**: “As opposed to rule-based reasoning, in which the reasoner engages in the formulation of general rules, or theories, in case-based reasoning one only finds similarities between different cases, and uses these similarities to draw analogies” (Gilboa et al. 2011, 6). Economists are indeed informed by such analogies: when the assumption of perfect competition is relaxed, and barriers to entry exist, for example, firms may make positive profit in the long run.

It is possible that, despite our best efforts as undergraduate educators, the methodological intentions of the economic models we teach get lost. There is a danger that students fail to appreciate the depth of the conditional or case-based approach used in a given model. Introductory-level students may be more concerned with memorizing the characteristics of a

perfectly competitive market than with understanding the role these characteristics play as critical assumptions in the competitive model. As courses progress in difficulty - and often, mathematical sophistication - students increasingly focus on the algebra and calculus skills needed to solve the model in front of them. If a greater proportion of effort is spent on solving for the Bertrand-Nash equilibrium, students may more easily lose track of the key role an assumption of heterogeneous or homogeneous products plays in the Bertrand market.²

A graduate with an economics degree should leave school with a cognitive toolkit she can use to think about economic phenomena and problems out in the world.³ What if she encounters a question not explicitly covered in the economics curriculum? To address such a question, her toolkit would need to include not only some basic knowledge of canonical models, and quantitative abilities to solve these models, but also experience in (1) identifying the underlying characteristics of the question of interest, (2) prioritizing those characteristics by the degree to which they are critical to the understanding of the question, and (3) ultimately selecting, building, or adapting a model which is appropriate to address their question. This need is captured well by Woolley (2014):

² This is not to suggest that the mathematization of economic models is not welcome. Rodrik, for example, describes the need for mathematics in models for both clarity and consistency:

First, math ensures that the elements of a model - the assumptions, behavioral mechanisms, and main results - are stated clearly and are transparent [...] The second virtue of mathematics is that it ensures the internal consistency of a model - simply put, that the conclusions follow from the assumptions. This is a mundane but indispensable contribution. Some arguments are simple enough that they can be self-evident. Others require greater care, especially in light of cognitive biases that draw us toward results we want to see. Sometimes a result can be plainly wrong. [...] Here, math provides a useful check (Rodrik 31-32).

Students' mental bandwidth may be more heavily taxed by the required technical skills in upper-level courses, and as a result, a deep understanding of a model's features, underlying assumptions, and limitations is in jeopardy of being sacrificed.

³ This is how I interpret the common objective among colleagues that an economics major should ultimately learn how to "think like an economist."

[w]hen students are taught about theory, they are presented with simple, pre-abstracted, models. It's like being asked to re-arrange the furniture in de-cluttered, minimalist home - a useful exercise that introduces the student to basic principles of design and organization. Yet when students go out to build their own theories, they are faced with explaining a world of complexity. Before they can make any progress, they have to throw a whole load of stuff out. But economic theory courses spend little time explicitly discussing methodology: what makes for a good explanation, and thus should be in the model - e.g. incentives, prices - and what can safely be bracketed out. So people end up lost.

Modeling an originally observed phenomenon requires a different approach than solving a predetermined model assigned by the professor. As Woolley suggests, students lack experience in **model selection**, which requires an understanding of different models and their assumptions, and asks the modeler to choose the best model for the phenomenon.⁴ If economics is, according to Keynes, “the science of thinking in terms of models joined to the art of choosing models which are relevant to the contemporary world,” then training students to think like economists requires direct engagement with the practice of joining economic science and economic art.

⁴ When considering model selection, exposure to and understanding a multiplicity of models expands the modeler’s choice set. Rodrik (2015) characterizes the strengths and pitfalls of this multiplicity in the book *Economics Rules*: “Different contexts - different markets, social settings, countries, time periods, and so on - require different models. And this is where economists typically get into trouble. They often discard their profession’s most valuable contribution - the multiplicity of models tailored to a variety of settings - in favor of the search for the one and only universal model. When models are selected judiciously, they are a source of illumination. When used dogmatically, they lead to hubris and errors in policy” (Rodrik 2015, 11). Teaching model selection should balance the depth of students’ understanding of models with the breadth of exposure to diverse models.

The Economics of Online Dating provides a uniquely⁵ focused opportunity to teach both the science of economic modeling and the art of (theoretical) model selection and specification. The Course Competencies section of the syllabus⁶ states that a student in The Economics of Online Dating should learn to:

- Recognize parallels between economic concepts, including search theory, game theory, incomplete information, and matching markets, and the world of online dating;
- Identify broader real-world implications of these economic concepts;
- Cultivate a theoretical economic toolkit for modeling optimal individual decision making, and strategic decision making; incomplete information; and equilibrium in both non-cooperative and cooperative (matching) scenarios;
- Apply this toolkit to formally model a broad range of interactions: from online dating to markets for insurance, education, social media, and more;
- Dissect the methodological strengths and limitations of economic models;
- Express confidence in independently modeling and analyzing real world phenomena using this theoretical economic toolkit.

⁵ Related research similarly addresses the problem of teaching students to join economic theory to the world. Motahar (1994) implements a modeling course which bridges micro theory, macro theory, and econometric techniques to teach students how to, for example, link data to models of optimal firm decision making. Green et al. (2013) uses scaffolded assignments in intermediate micro to move students from well-structured to ill-structured economic problem solving. However, Green et al.'s use of "ill-defined" problems still requires students to analyze problems from a list provided by the instructors. The Economics of Online Dating tackles the problem by allowing students to model phenomena of their own choosing, as long as the modeler can justify the connection between the phenomenon and the theoretic tools used. The course directly challenges students to connect models to the world they experience, engaging students in the pursuit not just of *solving ill-defined problems*, but of *defining the problem to be solved*. The greater freedom students face in model selection presents a unique challenge central to the pedagogical rationale for The Economics of Online Dating.

⁶ Course materials, including a syllabus, schedule and due dates, sample assignments, and examples of student models, can be found on the course website at www.pugetsound.edu/faculty-pages/amonaco/the-economics-of-online-dating/.

The overarching objective for The Economics of Online Dating is to better equip students to use economics to model the world - to think like an economist. Students' first step in this pursuit is to understand economic theory and its connection to real world phenomena more deeply, as is reflected in the first three competencies. These competencies resemble those one might find in a traditional theory course. The remaining competencies concern the overarching objective: student modeling skills. Importantly, the course directly targets these modeling competencies in two ways.

First, there is a commitment to methodological discussion. As students learn theoretical tools, we explicitly discuss the tradeoffs between choosing a specific model (with exact numerical values for probabilities and payoffs, for example) and a general model (using variable instead of numerical parameters.) We ask a battery of questions addressing modeling technique: what are the relevant extensions of this model? Is the analogy presented in this model appropriate for the real world phenomenon it represents? What features are missing from the model, and how critical are these features?

Second, students produce numerous original models over the course of the semester. They engage in peer review of others' models, present and defend their models to the class, and have continuous opportunities to refine their models as the semester progresses.⁷ Students get hands-on experience with model selection, identifying the strengths and limitations of their models and balancing the model's explanatory power with its tractability.

⁷ The importance of revision processes is emphasized in writing instruction and educational psychology research. When students engage in revision, they strengthen the connections between working memory, long-term memory, cognitive knowledge, and metacognition. Butterfield, Hacker, and Albertson (1996) give a meta-analysis of text revision research, of which Fitzgerald (1987) is a cornerstone.

The emphasis on modeling experience is motivated by psychologists' studies of the concept of **self-efficacy**, which is a student's belief in her own abilities to achieve her goals. Originally developed by Albert Bandura,⁸ the processes through which efficacy beliefs produce their effects are simultaneously cognitive, motivational, and affective (Bandura 1997, 116). On the cognitive front, students with high self-efficacy are able to work more calmly and thoughtfully, set higher goals, develop greater intrinsic interest in the material, and exert more self-regulation, all attributes associated with handling difficult and complex tasks which require the synthesis of diverse skills and ideas. The impact of self-efficacy on student motivation is supported by attribution theory (wherein self-efficacious students are more willing to credit past successes to personal effort and therefore view achieving future goals as more controllable), expectancy-value theory (wherein self-efficacious students are more likely to foresee positive results from their efforts), and goal theory, wherein "efficacy beliefs influence the level at which goals are set, the strength of commitment to them, the strategies used to reach them, the amount of effort mobilized in the endeavor, and the intensification of efforts when accomplishments fall short of aspirations" (Bandura 1997, 136). Self-efficacy can also lead to an improved ability to regulate anxiety and mitigate negative or depressing thoughts through an increased sense of control; this can motivate a student to act more proactively prior to an anticipated negative event, or to respond more positively to a negative event that has occurred.

⁸Bandura (1997) is a canonical resource which lends comprehensive theoretical and empirical support to self-efficacy theory. Chapter 4 discusses the processes through which self-efficacy works, while Chapter 6 details the relationship between self-efficacy and cognitive functioning in an educational context.

Self-efficacy has been linked to undergraduate student academic performance in a number of studies.⁹ Importantly, Bandura identifies four factors which are associated with increased self-efficacy, the most influential of which is *enactive mastery experience*:¹⁰ “Successes build a robust belief in one’s personal efficacy. Failures undermine it, especially if failures occur before a sense of efficacy is firmly established. If people experience only easy successes, they come to expect quick results and are easily discouraged by failure. A resilient sense of efficacy requires experience in overcoming obstacles through perseverant effort” (Bandura p. 80). This is the prime impact of Woolley’s suggestion that learning how to do theory is like riding a bicycle: modeling experience is central to training better economic modelers because persistent cultivation of that experience improves students’ self-efficacy.

Modeling creation in particular develops enactive mastery experience by asking students to synthesize conceptual knowledge and technical skills in an ill-defined environment. Rather than pre-defined problems with strategies which are prescribed by the instructor, models are generated by students themselves and, as problems to be solved, exist in a more open framework. This forces students to engage in **self-guidance**, teaching themselves the specific strategies required to analyze their own application: “Guided self-instruction does more than impart strategy information. To the extent that using the strategies produces good results, it confirms their value. Anticipated benefits produce incentive motivation to apply cognitive aids that work well. In addition, successful self-guidance provides repeated affirmations of personal agency -

⁹ There is truly a vast literature in educational psychology on self-efficacy and its role in educational attainment. Pajares (1996) gives an early review across educational levels, while Multon, Brown, and Lent (1991) provide a meta-analysis of 38 separate studies. Chemers, Hu, and Garcia (2001) conduct a longitudinal study which finds a significant positive correlation between self-efficacy and academic performance among first-year college students.

¹⁰ The other factors which influence self-efficacy are: vicarious experience (“modeling” or seeing peers succeeding); verbal persuasion (encouragement or social persuasion); and, physiological and affective factors.

that one has gained the ability to exercise control over one's own thinking processes and performances. Self-guidance training has been shown to be a self-efficacy builder [...]” (Bandura 224).¹¹

Moreover, the semester-long focus on student model creation represents a commitment to a combination of proximal or short-term goals (individual modeling assignments) and long-term goals (scaffolding to more complex models, the course modeling project) which are unique to each student. This commitment to personalized goals undergirds the acquisition of enactive mastery experience each student needs to develop self-efficacy: “The development of cognitive competencies requires sustained involvement in activities. If appropriately structured, such pursuits provide the mastery experiences needed to build intrinsic interest and a sense of cognitive efficacy when they are lacking. This type of enduring self-motivation is best achieved through personal challenges that create a sense of efficacy and self-satisfaction in performance accomplishments. The motivating power of personal goals is partly determined by how far into the future they are projected. [...] Self-motivation is best sustained by combining a long-range goal that sets the course of one's endeavors with a series of attainable subgoals to guide” (Bandura 217).

If students are to be well-equipped to model the world, they must work beyond an *understanding* of how canonical economic theory works and *practice* joining economic theory to abstract phenomena. Learning theoretical building blocks and discussing the methodology of

¹¹ Self-guidance in an open framework - solving an ill-defined problem rather than an instructor-provided one - is more effective because it forces students to **improvise optimal problem solving strategies**: “Opportunities to improvise self-guidance convey a more generalized sense of personal causation than self-instruction in strategies provided by others. One can repeat what one has been told without much understanding or proficiency in adapting cognitive subskills that were taught in variable circumstances. By contrast, improvisation involves the exertion of personal agency. [...] Improvisational self-guidance produces a higher sense of personal efficacy and intellectual performance than does externally prescribed self-guidance.” (Bandura 224)

economic modeling support this practice. Ultimately, however, it is through experience in modeling - the struggle of choosing a model, deciding how to tailor an existing model, even scrapping and reinventing a model that is oversimplified, unrealistic, or intractable - that students encounter obstacles and persevere through the challenge of joining a model to an observation in the world.

Three Stages of Teaching Modeling

Each module in The Economics of Online Dating follows the same three-stage progression for teaching students how to model.¹² Here, the module on search theory will be used to motivate each stage of the approach and the pedagogical connections between stages.

Stage 1: Discussion

The discussion stage **introduces students to the key concepts of the module**, in a format which encourages student agency and promotes a classroom culture of critical thinking. Each module begins with assigned readings and an in-class discussion of those readings. The discussion is anchored in the appropriate chapter(s) from Oyer, with additional non-technical articles woven in. I moderate the discussion loosely, taking down keywords and phrases on the

¹² This three-stage sequence composes the entire course, but could easily be integrated as an independent learning module in any number of courses. I discuss this potential in the section on Course Implementation.

board to provide a visual map of the discussion. This allows the entire class to connect and relate ideas across what can be an active 80-minute class period.¹³

In the search theory module, students contribute their own examples of contexts in which they search: choosing a college, choosing an outfit for a formal affair, choosing a dating partner or a sexual partner. As the discussion progresses, students organically uncover salient features of search theory, such as the opportunity cost of the search and the probability of a successful search. This format **promotes student agency**, as students use their own applications to forge stronger connections to the concepts they will encounter later in the module.

The openness of the discussion format allows students to probe the uncertainty surrounding key concepts. Students are encouraged to push back, to critique arguments, and to ask questions of me and of their classmates. **Cultivating a classroom culture of critical thinking** highlights the nebulous nature of economic modeling. Rather than accept the professor's word that the model is ideally constructed, students must learn to question how well its analogy fits. Students' willingness to challenge my models (in Stage 2), peers models, and their own models (in Stage 3) begins with encouragement in the discussion stage.

Stage 2: Theoretical Tools

¹³ The in-class discussion is complemented with a follow-up online discussion. I use the platform Moodle (standard at our institution) to establish discussion boards, encouraging and requiring students to participate in the online discussion. This ensures all students have a comfortable space in which to contribute, regardless of their willingness to speak in class on any given discussion day.

This stage most resembles a traditional lecture.¹⁴ I teach the economic tools¹⁵ needed to think meaningfully about search theory: (1) utility theory, including diminishing marginal utility, since we need a way to measure how an individual decision maker values alternative outcomes; and, (2) expected utility, including basics of probability, since searches are inherently risky, with some likelihood of success (finding a dress that fits, finding a partner that you like) and some likelihood of failure.

With these tools in the students' toolkit, I introduce an initial search theory model: the model of George, a job seeker. George is currently employed, and considers searching for a new job. The outcome of the search is unknown ahead of time, the search has an opportunity cost, and there is a default state (his current job) in which he remains if he decides not to search. The default state generates reservation utility, and George must decide whether to engage in a risky search or refuse to search and earn the reservation utility.

The model is introduced and solved numerically, as shown in Figure 2. This allows students to transition from economic concepts (search cost, probability of successful search) first to numerical values (search cost of 240 utils, 0.2 probability of successful search) which generate an *unconditional* prediction: since the expected utility of the search (4008 utils) exceeds the reservation utility (4000 utils), George should search.¹⁶ A discussion of the limitations of

¹⁴ This is not to say there are only lectures at this stage. In the module on cheap talk, for example, the class plays a live version of a Prisoner's Dilemma-Golden Balls game both with and without cheap talk.

¹⁵ For terminological clarity, I distinguish between economic *concepts* (economic ideas defined in words as in Stage 1) and economic *tools* (mathematical representations of concepts implemented in economic models in Stage 2.)

¹⁶ The choice to present the numerical model prior to the general model is particularly important for the first module of the course, given the wide spectrum of mathematical experience across students. By beginning with a lower mathematical barrier to entry (the numerical model), this scaffolding encourages students' confidence in their quantitative skills at an early juncture. Additionally, the unconditional nature of the numerical prediction ($4008 > 4000$) is simpler to grasp early in the semester than the conditional nature of a prediction which relies on ranges of parameter values ("If the search cost is above x , then George should ..."); this scaffolds students' understanding of model predictions.

numerical models follows: what if the probability of success or the search cost take different values? Can a more general model be constructed?

The general model (Figure 3) is then presented, with 5 variable parameters: p is the probability of a successful search; $u(\bar{u})$ is the reservation utility; u_H is the net utility from a successful search; u_L is the net utility from a failed search; and c is the opportunity cost of the search. Although it requires a bit more algebra, the *conditional* prediction of this model is found: George should search whenever the expected utility of the search exceeds $u(\bar{u})$, or whenever

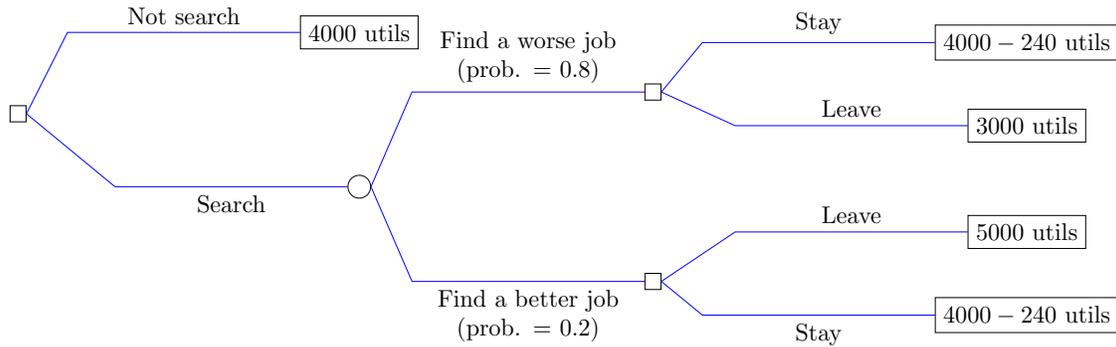
$$p(u_H) + (1 - p)(u(\bar{u}) - c) > u(\bar{u})$$

Since students have already seen the numerical iteration of the model, they have insight into the algebraic solution to the model. They are engaging in the same exercise - comparing the reservation utility with the expected utility of the search - but instead of comparing numerical values, they are analyzing an algebraic expression. The scaffolding which moves from numerical to general models eases the mathematical transition for many students.¹⁷

After the general model is presented, students' critical thinking can be fully engaged. We discuss the tradeoff between the mathematical ease of the numerical model and the explanatory power of the general model, even showing that the general model embeds the numerical model. We rearrange the inequality above, noting that searching is optimal when the expected gain above reservation utility exceeds the expected cost of the search, or that the net expected gain of the search is positive. We analyze comparative statics, showing that as c decreases, the expected gain of the search increases, magnifying the incentive of George to search. We suggest adjacent

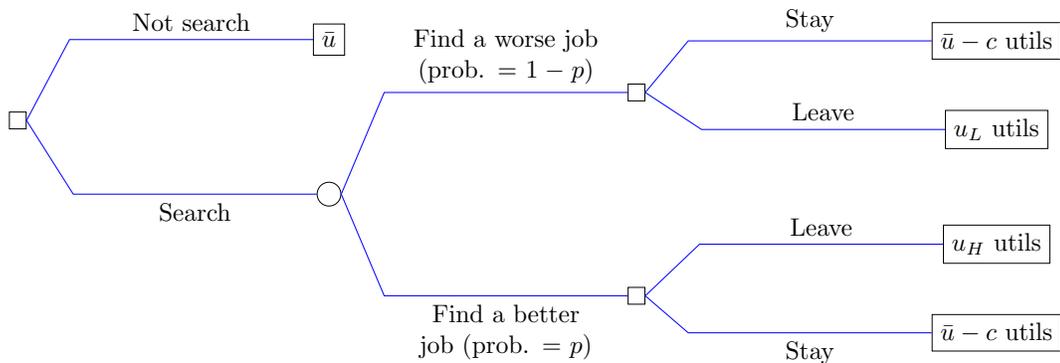
¹⁷ There are degrees of pedagogical flexibility here. In some subsequent modules, the transition moves from numerical model to a hybrid model with numerical parameters and one or more variable parameters; in others, the first model presented is a hybrid numerical-variable model. Scaffolding from numerical to variable parameters occurs both within and across successive modules.

models to capture dress shopping and online dating. We discuss criticisms of the model (“In real life, I can search more than once!”), and extensions to address these criticisms (by introducing multiple rounds of search into the larger decision tree).



Assume $u_H = 5000$, $\bar{u} = 4000$, $u_L = 3000$, and $c = 240 > 0$, where u_H and u_L are inclusive of search costs.

Figure 2: Numerical version of the job search model.



Assume $u_H > \bar{u}$, $\bar{u} - c > u_L$, and $c > 0$, where u_H and u_L are inclusive of search costs.

Figure 3: General version of the job search model.

Even though the second stage most resembles a traditional economics lecture, it cannot be one-sided. This approach hinges on students’ active participation in the presentation of the search theory model. Students must think critically, ask questions, challenge assumptions,

suggest extensions, and see the model *not as a final product but as an unfinished analytical iteration of an economic idea*. Along with developing students' economic theory toolkits by scaffolding quantitative skills, the second stage continues to cultivate a culture of critical thinking, laying the groundwork for original model creation.

Stage 3: Model Building

By the third stage of the module, students have now contributed to class discussions and explored models with search theoretic features. Their next task is to create a search theoretic model on their own. As a homework assignment¹⁸, each student builds an original model of a phenomenon using what they have seen in this and previous modules. Students are encouraged to be original, and have modeled: choosing whether or not to buy a new skateboard; choosing between dining at a familiar restaurant or a new restaurant; deciding whether or not to transfer colleges; comparing the cost of shopping in-person versus shopping online; searching for a rare collectible baseball card; buying a new home; searching for a date on an online dating app given a risk of being “catfished”; and, searching for a new significant other while currently in a relationship.

The wide range of applications highlights how students creatively relate search theory to events from television, movies, their personal lives, and their own imagination. Additionally, some students will work in features not expressly taught. The shopping in-person versus shopping online model, for example, weaves in an additional search option, and compares

¹⁸ Each formal modeling assignment is intentionally open-ended: students can choose to model any scenario they choose for the theoretical topic, provided they include 1) a description of the scenario in words; 2) the model itself, including clear statements of any assumptions or parameter restrictions; and 3) a prediction or solution (such as an expected utility comparison to predict an optimal search choice for the decision maker) as the model demands. Grading expectations for these are provided in a Teaching Guide on the course website.

expected utilities of two searches with difference search cost parameters under the hypothesis that online search costs are likely lower than in-person search costs. Across the class, students will vary the level of generality in their models.¹⁹ Less experienced students are typically more conservative and numerical in their modeling, while juniors and seniors are more likely to branch out with extensions and increased generality and complexity (such as expanding to two search cost parameters instead of one).

The variation across applications, student experience, and degrees of generality plays a prominent role in the peer review process. Model due dates are peer review model workshop days. Students are randomly²⁰ assigned into groups of 3 or 4 for peer review, where they each read the models of the other group members. Models are passed around the group, and in rotation, each student fills out a short response to the model they are reviewing. The responses include questions to force peers to **directly address methodological points** as they relate to the model: is the real world phenomenon being modeled clearly stated? How well does the model match the real world phenomenon? Is the prediction of the model well-supported mathematically? At the end of peer review, each student collects the responses to his or her model, taking home valuable feedback. After the rotating review has been completed, groups

¹⁹ The same is true, though to a lesser degree, with regard to the degree of originality in student models. Some stick closer to the original model, while others opt for more adventurous takes. However, even those students who begin the semester with more familiar models gain confidence as the course progresses.

²⁰ Here, the random rematching ensures students do not just form groups with friends. This discourages rubber stamping and allows students to see a wider variety of modeling styles as the semester progresses.

have an opportunity to discuss each model, to clarify any points of confusion, or ask for feedback on some specific aspect of the model.²¹

After groups have finished their work, each group “elects” one member to the board to teach the class their model.²² The process of students teaching is an informative process for students in the audience, and a valuable opportunity for the teachers to cement their own knowledge. This technique is supported by the **learning by teaching**²³ approach which encourages student expertise and command of technical concepts, and develops students’ communication skills both directly (through the transmission of the model visually and verbally) and indirectly (through responses to questions from peers and the professor).

The third stage is where the proverbial rubber meets the road. Students use their growing set of theoretical tools to **construct original models**, and **workshop those models** in small group peer review and through teaching the models to the class. Importantly, the third stage is the most critical stage in promoting student self-efficacy, as model-building experience encourages self-efficacy through its strongest channel: enactive mastery experience.

Course Implementation

²¹ Students do not submit model assignments on peer review days. Rather, students are asked to resubmit their models at the next class period. This allows students to use feedback and critique their own models, taking the opportunity to make improvements in design, correct mathematical errors, or incorporated suggested extensions. The revision and resubmission process reinforces the evolving nature of economic modeling.

²² Often, this is done less than proportionally across groups. Through the peer review process, I monitor groups’ progress and identify models to be presented on the board. Sometimes these are models which are particularly sound, incorporate a truly unique feature, present a novel application, or are in some way unfinished and in need of class-wide feedback, and I will directly ask a student to share their model on the board. Additionally, the flexibility I maintain in deciding who goes up to teach allows me to balance all students’ opportunities to teach.

²³ This approach, developed by Jean-Pol Martin, is often abbreviated from its original German *Lernen durch Lehren* (literally learning by teaching) as LdL. See Grzega and Schoner (2008) and Grzega (2005).

The Economics of Online Dating is an upper-level elective with a maximum of 20 students at our institution - a 4-year liberal arts college - and has our introductory economics course as its only prerequisite. Roughly 80% of students are juniors or seniors, and approximately half are economics majors.²⁴ Collecting students from diverse academic backgrounds enhances discussions, permits critiques from a variety of perspectives, and exposes students to ideas and peer-created models with influences from political science, sociology, computer science, and the humanities. This promotes the flexibility of modeling as a tool beyond economics, and provides both economics majors and non-economics majors with a better perspective on the role economic theory plays within the discipline.²⁵

The three-stage approach to teaching modeling can easily be applied to other areas of economics, particularly those which lend themselves to economic modeling, such as environmental economics, microeconomic theory, industrial organization, public finance, game theory, or macroeconomics. It could serve as a repeated module through an entire course (as implemented in The Economics of Online Dating), or as an independent two-week module within an existing course.²⁶ In either case, the marginal cost to the instructor of implementation

²⁴ There is no mathematics prerequisite or review for the course. Students are only required to use algebra.

²⁵ While exposure to this perspective is critical for economics majors to better understand their own field of study, openness to students outside of economics is important as well since many of economics' harshest critics are outside of the field. Rodrik again:

In my interactions with many noneconomists and practitioners of other social sciences, I have often been baffled by outsider views on economics. Many of the complaints are well known: economics is simplistic and insular; it makes universal claims that ignore the role of culture, history, and other background conditions; it reifies the market; it is full of implicit value judgments; and besides, it fails to explain and predict developments in the economy. Each of these criticisms derives in large part from a failure to recognize that economics is, in fact, a collection of diverse models that do not have a particular ideological bent or lead to a unique conclusion. Of course, to the extent that economists themselves fail to reflect this diversity within their profession, the fault lies with them (p. 6).

An open and honest dialogue between students from within and outside of economics - which may be stoked in this course - can help bridge this common point of misunderstanding.

²⁶ For example, I implement a two-week module on multisided platforms in intermediate microeconomics.

would be the preparation of discussion readings and any class time (for covering additional material or other in-class activities) forgone to make room for discussion days, methodological discussion, and peer workshop days. Grading demands for modeling assignments are moderate, comparable to advanced homework assignments.

Assessment

I analyze improvement in student modeling in Figure 4. For every student ($n = 21$), each of the six student models is scored on three components: degree of generality, uniqueness compared to the model presented in class, and degree of complexity. Each component is scored on a 1 to 3 scale, then averaged in the data below. For example, on degree of generality, a fully-numerical model would receive a 1, a model with some numerical and some variable parameters would receive a 2, and a general model with all variable parameters would receive a 3.²⁷ The data suggest that as the semester progressed, on average, students built more general models, were more willing to build models which differed from those they saw me present, and incorporated more complex elements (extensions, combinations of theoretical elements) into their models. One student built a complex traffic network to model his commute to campus, while cheap talk models stretched from restaurant servers' recommendations to the Suez Crisis - all of which came from students who had previously stuck to simpler iterations.

²⁷ On uniqueness, I scored a model with a 1 if the model was structurally identical to mine (I taught a 2x2 game matrix, and they submitted a 2x2 game matrix); a 2 if the model incorporated a minor extension (submitting a 3x3 matrix or introducing incomplete information); a 3 if the model incorporated a major extension or was entirely novel. On complexity, a score of 1 represented a model with only basic elements; 2 represented a model with a combination of at least 2 elements; a 3 represents a combination of multiple elements, or a unique twist on how elements were combined.

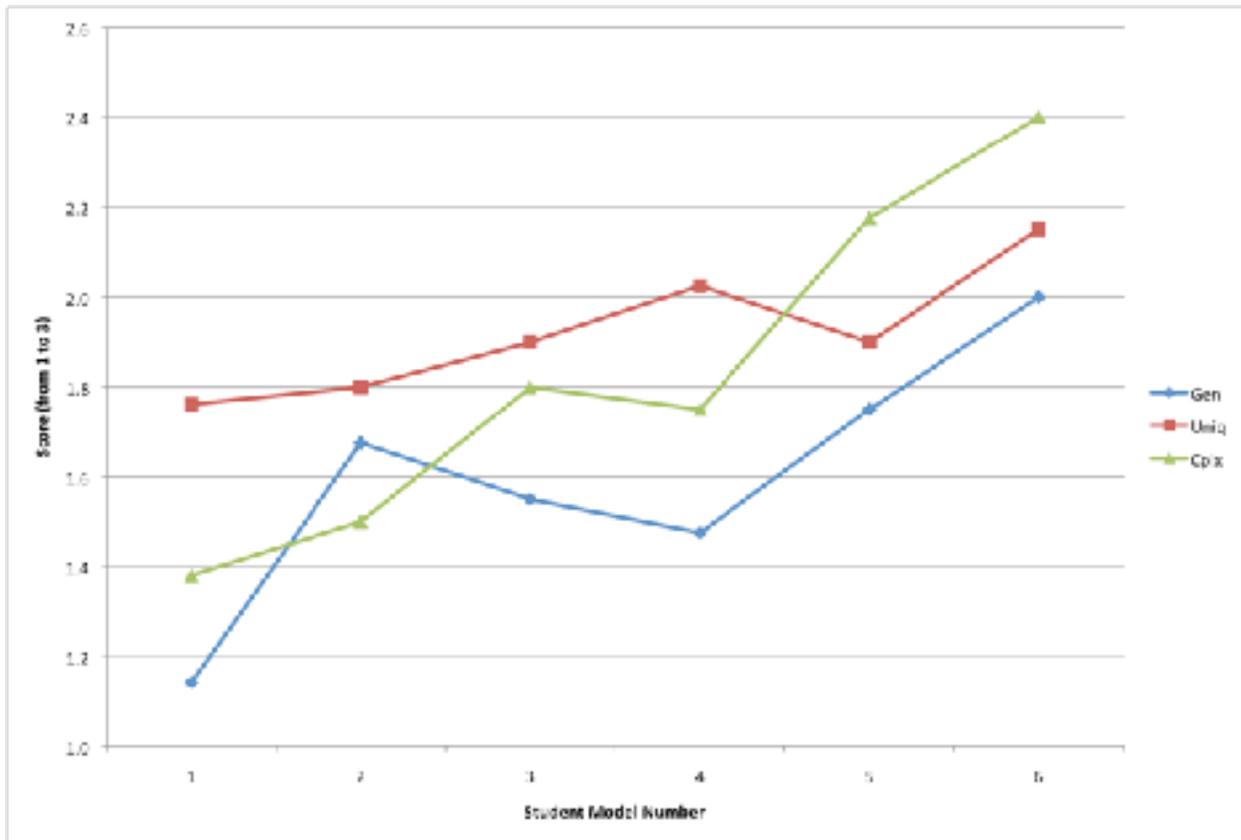


Figure 4: The evolution of students' models from their first to their sixth, on three components: degree of generality (Gen), uniqueness relative to the model I presented in class (Uniq), and degree of complexity (Cplx). Along all three dimensions, the average scores improved as the course progressed.

Student responses on course evaluations can also provide qualitative insight into the effectiveness of this course at achieving its objectives. On the surface, students overwhelmingly find the material engaging, as evidenced in a typical comment: “Online dating is a fun and intriguing way of presenting economic questions and analysis.” Moreover, nearly all students find the course challenging.²⁸ A closer look reveals several themes from student feedback (all quotes below are directly from students):

²⁸ The diversity in student backgrounds creates different challenges for different students. Non-majors find more of the content itself to be challenging as it is newer to them. While economics majors, even seniors, may have encountered some concepts in a prior class, the exercise of synthesizing their broader economic toolkit to create a model is its own challenge.

A. The course prepares students for independent research. All economics majors at our institution write a senior thesis, an original and independent semester-long research paper which serves as a synthesis of their economics studies. The senior economics majors enrolled in The Economics of Online Dating shared similar reactions to the course. One said, “I thought this class was great and only wish I had taken it before my thesis. It provided a great way to look at different problems and apply the models we have learned in other econ classes to different real world problems.” Another: “Every economics major should take this course - or a similar challenging assumption course before writing their thesis.” Students who had completed a thesis recognized - based on their own experience struggling with independent research - the value in the practice of modeling and “joining” economic tools to their own ideas.

B. The course promotes student independent thinking. The open-ended nature of modeling assignments “allows students to engage the material in a way that is helpful and informative to themselves.” and encourages student autonomy by helping students “find their own interests connected to the material.” Importantly, students began to attribute their learning to their own levels of effort, as one shares: “Since the model building, discussions, and lectures are very open ended you get out of this class what you put into it. There are many great opportunities to challenge yourself.”

C. Both the pedagogical approach and the selection of material complement the broader economics curriculum. The course strikes a balance between presenting new concepts and drawing connection to those in prior courses. It “ties in learning elements from other econ topics,” and “does a good job of reinforcing concepts learned in other courses, and in presenting new material.” Econ majors find modeling exercises and peer review activities productive. One

said “I especially enjoyed writing rough drafts of models and then getting feedback from students during the workshops,” while another stated “Doing the models and workshopping them was extremely helpful and very different from what I’ve done in my other econ classes.”

Conclusion

The Economics of Online Dating teaches economic modeling at the advanced undergraduate level using a three-stage progression through a sequence of content modules. Self-efficacy theory stresses the role of enactive mastery experience in promoting students’ beliefs in their own abilities to achieve their goals, and this approach to teaching modeling provides students with this experience in model creation and teaches students to navigate the gap between the “world of complexity” and the economic models we as economists use to analyze that world.

REFERENCES

- a. Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. New York, NY: W.H. Freeman.
- b. Barclay, E. (2016, June 20). The perversity of shopping for love. *Vox*. Retrieved from <http://www.vox.com/2016/6/20/11949988/america-dating-consumerism> on October 25, 2016.
- c. Bobrinskoy, M. (2015, January 13). Alexandra [Video file]. Retrieved from <https://www.youtube.com/watch?v=SyA5gzqA3nU> on October 25, 2016.
- d. Bruffee, K. (1993). *Collaborative Learning: Higher Education, Interdependence, and the Authority of Knowledge*. Baltimore, MD: The Johns Hopkins University Press.

- e. Butterfield, E., Hacker, D., and Albertson, L. (1996). Environmental, Cognitive, and Metacognitive Influences on Text Revision: Assessing the Evidence. *Educational Psychology Review*, 8(3): 239-297.
- f. Carrott, J. (Host). (2012, February 3). Golden Balls: the weirdest split or steal ever! [Video file]. Retrieved from <https://www.youtube.com/watch?v=S0qjK3TWZE8> on October 25, 2016.
- g. Chemers, M. M., Hu, L. T., & Garcia, B. F. (2001). Academic self-efficacy and first year college student performance and adjustment. *Journal of Educational psychology*, 93(1): 55-64.
- h. Dixit, A., Skeath, S., and Reiley, D. (2009). *Games of Strategy, 3rd Edition*. New York, NY: W. Norton & Company.
- i. Fitzgerald, J. (1987). Research on Revision in Writing. *Review of Educational Research*, 57(4): 481-506.
- j. Fivethirtyeight. (2015, August 12). *What Online Dating Was Like in the 1960s* [Video file]. Retrieved from <http://fivethirtyeight.com/features/what-online-dating-was-like-in-the-1960s/> on October 25, 2016.
- k. Fry, H. (2015). *The Mathematics of Love*. New York, NY: TED Books, Simon and Schuster.
- l. Gilboa, I et al. (2011). Economic Models as Analogies. *The Economic Journal*, 124(578).
- m. Green, G., Bean, J., and Peterson, D. (2013). Deep Learning in Intermediate Microeconomics: Using Scaffolding Assignments to Teach Theory and Promote Transfer. *The Journal of Economic Education*, 44(2): 142-157.
- n. Grzega, J. (2005). Learning By Teaching: The Diadactic Model LdL in University Classes. Retrieved from <http://www.joachim-grzega.de/ldl-engl.pdf> on September 13, 2016.

- o. Grzega, J. and Schöner, M. (2008). The didactic model Ldl (Lernen durch Lehren) as a way of preparing students for communication in a knowledge society. *Journal of Education for Teaching*, 34 (3): 167-175.
- p. Harford, T. (2008). *The Logic of Life: The Rational Economics of an Irrational World*. New York: Random House.
- q. Harrington, J. (2009). *Games, Strategies, and Decision Making*. New York, NY: Worth.
- r. Keynes, J. M. (1983). *The Collected Writings of John Maynard Keynes*. (Vol. XIV, 295-297). Macmillan.
- s. Landsburg, S. (2007). *More Sex is Safer Sex: The Unconventional Wisdom of Economics*. New York, NY: Free Press, Simon and Schuster.
- t. Motahar, E. (1994). Teaching Modeling and Simulation in Economics: A Pleasant Surprise. *The Journal of Economic Education*, 25(4): 335-342.
- u. Multon, K. D., Brown, S. D., & Lent, R. W. (1991). Relation of self-efficacy beliefs to academic outcomes: A meta-analytic investigation. *Journal of counseling psychology*, 38(1): 30-38.
- v. Nelson, L. (2015, April 7). College admissions is broken. Here's how to fix it. *Vox*. Retrieved from <http://www.vox.com/2015/4/7/8355247/college-admissions-terrible-preferences> on October 25, 2016.
- w. Osborne, M. (2004). *An Introduction to Game Theory*. New York, NY and Oxford, UK: Oxford University Press.
- x. Oyer, P. (2014). *Everything I Ever Needed to Know About Economics I Learned from Online Dating*. Boston, MA: Harvard Business Review Press.

- y. Pajares, F. (1996). Self-efficacy beliefs in academic settings. *Review of educational research*, 66(4): 543-578.
- z. Perloff, J. (2015). *Microeconomics, 7th edition*. Boston, MA: Pearson.
- aa. Rodrik, D. (2015). *Economics Rules: The rights and wrongs of the dismal science*. New York, NY: Norton.
- bb. Roth, A. and Sotomayor, M. (1990). *Two-sided matching: A study in game theoretic modeling and analysis*. Cambridge, UK and New York, NY: Cambridge University Press.
- cc. Rubenstein, A. (2006). Dilemmas of an Economic Theorist. *Econometrica*, 74(4): 865-883.
- dd. Spence, M. (1973). Job Market Signaling. *The Quarterly Journal of Economics*, 87(3): 355-374.
- ee. Slater, D. (2013). *A Million First Dates: Solving the Puzzle of Online Dating*. New York, NY: Penguin Group.
- ff. Talwalkar, P. (2014). *The Joy of Game Theory: An Introduction to Strategic Thinking*. Createspace Independent Publishing Platform.
- gg. Talwalkar, P. (2015, February 10). Game Theory Tuesdays: Why True Love Cannot Conquer Game Theory [Web log post]. Retrieved from <http://mindyourdecisions.com/blog/2015/02/10/game-theory-tuesdays-why-true-love-cannot-conquer-the-nash-equilibrium/> on October 25, 2016.
- hh. Talwalkar, P. (2015, March 3). The Stable Marriage Problem (Gale-Shapley Algorithm) – An Algorithm Recognized In the 2012 Nobel Prize And Used In The Residency Match [Web log post]. Retrieved from <http://mindyourdecisions.com/blog/2015/03/03/the-stable-marriage->

- [problem-gale-shapley-algorithm-an-algorithm-recognized-in-the-2012-nobel-prize-and-used-in-the-residency-match/](#) on October 25, 2016.
- ii. Varian, H. (2010). *Intermediate Microeconomics: A Modern Approach, 8th edition*. New York, NY and London, UK: W. W. Norton and Company.
- jj. Waldman, D. and Jensen, E. (2013). *Industrial Organization: Theory and Practice, 4th edition*. Boston, MA: Pearson.
- kk. Wallace, J. (2014, July 10). Game Theory Secrets for Parents. *Wall Street Journal*. Retrieved from <http://www.wsj.com/articles/game-theory-secrets-for-parents-1405005848> on October 25, 2016.
- ll. Wass, R. and Golding, C. (2014). Sharpening a tool for teaching: the zone of proximal development. *Teaching in Higher Education*, 19 (6): 671-684.
- mm. Watson, J. (2008). *Strategy: An Introduction to Game Theory, 2nd edition*. New York, NY and London, UK: W. W. Norton and Company.
- nn. Webb, A. (2013, April). TEDSalon NY2013: How I Hacked Online Dating [Video file]. Retrieved from http://www.ted.com/talks/amy_webb_how_i_hacked_online_dating on October 25, 2016.
- oo. Whelan, C. (2010). *Naked Economics: Undressing the Dismal Science*. New York, NY: Norton.
- pp. Whitman, G. and Dow, J. (Eds.). (2014). *Economics of the Undead: Zombies, Vampires, and the Dismal Science*. Lanham, MD: Rowman and Littlefield.
- qq. Woolley, F. (2014, July 20). Learning about theory does not teach people how to theorize [Web log post]. Retrieved from http://worthwhile.typepad.com/worthwhile_canadian_initi/

2014/07/learning-about-theory-does-not-teach-people-how-to-theorize.html on October 25,
2016.