

# **Collaborative Assignments without Regrets**

by

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## **Abstract:**

This presentation will present my experience with computer-supported assignments in which each student receives a unique exercise from an assignment template. Each exercise presents the students with a sequence of problems for which there exists a definitive unambiguous diagrammatical or numerical answer unique for that student. I encourage students to work together and facilitate group formation but I don't later regret that some students have used their group to obtain solutions without analysis.

This paper describes three parts of my work with this approach. First, I will present the results of a preliminary test of this approach showing a positive benefit for student exam performance compared to a traditional approach. Second, I will superficially describe the open source software that I use in my class and some of its current limitations. Third, I will describe the actual way I organize my large lecture class (generally over 200 students). In particular, I will describe the mechanisms I use to cope with inevitable computer and network failures and relate my experiences with this approach.

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### **Introduction**

Instructors of large introductory courses find it difficult to craft homework assignments that lead students toward an understanding of basic concepts and economize on scarce grading resources (often the instructors own time). At one extreme an instructor can present students with a set of computer scored multiple-choice questions. Properly constructed, multiple-choice questions can lead students through a process of problem solving and impose a very low cost for scoring while imposing only moderate preparation costs. But, students are often tempted beyond resistance to just tell each other the letter answer of each question, completely eliminating any learning. At the other extreme, instructors could adopt a private tutor approach by creating a special problem for each student and then score their response for both a correct answer and a proper derivation. This approach imposes very high costs for scoring and preparation.

This paper describes my experience with computer-supported assignments in which each student receives a unique exercise from an assignment template. Each 'ISEGS' exercise presents the students with a sequence of problems for which there exists a definitive unambiguous numerical answer unique for that student. I encourage students to work together and facilitate group formation but I don't later regret that some students have used their group to obtain solutions without analysis. Currently the software only checks the final answer by a student.

This paper describes three parts of my work with this approach. First, I will present the results of a preliminary test of this approach showing a positive benefit for student exam performance compared to a traditional approach. Second, I will superficially describe the open source ISEGS software that I use in my class and some of its current limitations. Third, I will describe the actual way I organize my large lecture class (generally about 180 students). In particular, I will describe the mechanisms I use to cope with inevitable computer and network failures and relate my experiences with this approach.

### **Preliminary Tests: Analysis of Averages**

During fall semester 2006 students in my Introductory Microeconomics and Introductory Macroeconomics classes worked on several homework exercises. The two courses cover the same topics during the first few weeks; in particular, both classes cover opportunity cost and present value. In the Micro class students worked on a present value paper exercise that was the same for all students and an opportunity cost ISEGS exercise that differed for each student. In the Macro class students worked on an opportunity cost paper exercise that was the same for all students and a present value ISEGS exercise that differed for each student. Approximately 10% of students attend both classes and took both exams. Table 1 shows which options each class performed.

	<b>Present Value</b>	<b>Opportunity Cost</b>
<b>mIcro</b>	Paper	ISEGS
<b>mAcro</b>	ISEGS	Paper

The ISEGS exercises depend on using some open source software called ISEGS. Students worked on the opportunity cost (in Macro) and present value (in Micro) exercises after they have completed other exercises using the same software so that lack of familiarity with the software would not artificially reduce performance or learning with the ISEGS exercises. A later section will describe the software more fully. Students had available to them a printed study guide prepared by Joerding for each exercise (paper and ISEGS) that focused on the basic concepts underpinning a solution and helped students understand an analytical approach that would produce a correct answer.

Each of the exercises requires students to compute answers that depend on a set of specified numbers; see Appendix 1. A teaching assistant scored the paper answers looking only to see if the student entered the correct answer for each question. The TA did not award partial credit nor were students asked to show their work. This process mimics the way ISEGS scores the individualized exercises. Students who do the ISEGS exercises can only record their numerical answers to the questions; they cannot show their work.

Subsequently, students took a midterm exam containing four questions similar to the exercise questions; see Appendix 2. Questions 1, 2, and 4 were identical to those the students had seen in the exercises except for changing the numbers. Question 3 varied the substance but still depended on the same basic concepts; compare question 3 of the exam (Appendix 2) to question 7 of the present value exercise (Appendix 1). Students were encouraged to show their work. The TA scored these questions allowing for partial credit if students showed that they understood the correct approach but perhaps committed an arithmetic mistake. Students in Micro took the exam two days before students in Macro.

**Table 2: Average Student Scores on Exam Questions and Exercises**

	Q1-PV (2pts)	Q2-PV (4pts)	Q3-PV (5pts)	Q4-OC (4pts)	PValue (28pts)	Op Cost (36pts)
<b>Micro: n=165</b>						
Average of students only in Micro	0.464	0.199	0.199	<b>1.877</b>	15.099	<b>14.430</b>
Students enrolled in both classes	0.286	0.286	1.071	<b>2.071</b>	16.429	<b>11.500</b>
<b>Macro: n=132</b>						
Average of students only in Macro	<b>0.805</b>	<b>0.381</b>	<b>0.805</b>	0.788	<b>13.508</b>	15.305
Students enrolled in both classes	<b>0.429</b>	<b>0.571</b>	<b>1.786</b>	2.214	<b>6.571</b>	19.714

**Bold face** = scores by students using ISEGS individualized exercises

*Results:*

Those students who worked on ISEGS exercises do better on subsequent exam questions than those students who worked on traditional paper exercises. Students not in both classes who worked on ISEGS opportunity cost exercises (Micro) nearly doubled their average exam performance compared to students who worked on traditional paper exercises, 1.877 vs 0.788.

Similarly, students not in both classes who worked on ISEGS present value exercises (Macro) nearly doubled their average exam performance compared to students who worked on traditional paper exercises, 0.805 vs. 0.464, 0.381 vs. 0.199, and 0.805 vs. 0.199.

The advantage for students doing the ISEGS present value exercise was particularly pronounced on question 3 (the Q3-PV column in Table 2). The students doing the ISEGS exercises outperformed the students doing the traditional paper exercises by 400%. Remember, question 3 asked students a question not only different numerically but also substantively. The better performance on question 3 by students who worked on the ISEGS exercises demonstrates an improved ability to generalize from the question they saw in homework to a question they had not seen before.

Those students enrolled in both classes saw each exercise at least two times: (1) as a paper exercise and (2) as an ISEGS exercise. In general they benefited on the exam from this exposure. Students doubly enrolled performed much better overall than the other students on questions 2-4 of the exam, e.g. 0.199 vs. 0.286 on question 2 (Present Value) for students simultaneously enrolled and who did the paper Present Value exercise. They performed worse on question 1. I suspect some sort of anomaly with question 1 of the exam. The question appears simple but perhaps something about the exercises inhibits students from seeing the simplicity and instead they see the question as 'tricky'.

*Comments:*

While gratifying, the statistics in Table 2 show some anomalies and perhaps chastens the author about overall success. First, the students performed very poorly on the exam questions. The sample data showed that scores tended toward a bimodal distribution with most students earning zero points and some earning full credit. Very disconcerting to see on questions the students had seen before in homework. However, these questions present very difficult challenges for introductory students. Overall, the students performed about as well on the multiple-choice part of the exam as in previous semesters, earning on average about 55% of the possible score.

Unfortunately, selection affects these results. The data only includes students who took the exam. It doesn't include students who dropped out before the exam. Both classes have a large component of the work that depends on computer access and experience. I don't think the two classes differ systematically in student abilities on this dimension, or other criteria relevant to student performance on the exams. There exists a slight tendency for students at WSU to take the micro class before the macro class but it has little effect.

For paper exercises, those students enrolled in both Macro and Micor classes earned more points on the exercises; 16.429 vs. 15.099 for Present Value and 19.714 vs. 15.305 for Opportunity Cost. But, students enrolled in both classes performed more poorly on the ISEGS version of the exercises than the paper versions; 6.571 vs. 13.508 and 11.500 vs. 14.430. This seems odd without any ready explanation. I know at least a couple students who misunderstood the assignment system and assumed they only had to do the assignment once for both classes.

## ISEGS

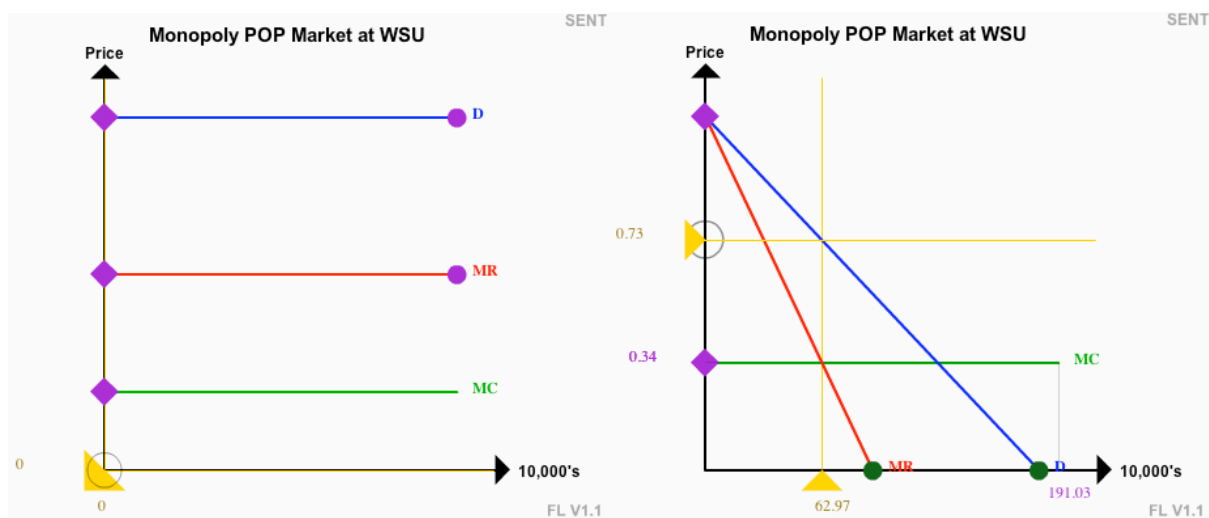
ISEGS stands for Individual Student Exercise Generating System. Educators can freely download the code to use and modify, as they desire, subject to an open source license. The software runs on a web server with PHP 5 and MySQL 5 services, two open source packages widely available on the Internet for many platforms (Linux, Windows, Mac OS). We test and develop the code with the Firefox browser, it currently does not run with Internet Explorer because of inadequate support by Internet Explorer for W3C standards. The browser must enable both JavaScript and Flash. You can find more information by contacting Wayne Joerding: [wjoerding@wsu.edu](mailto:wjoerding@wsu.edu).

I have worked with undergraduate students, mostly in computer science, to create this code. This project includes a side goal to provide students at Washington State University with meaningful experience on real world applications. Program development and production takes place on a Macintosh OS X system, but my student programmers have ported ISEGS to a Ubuntu Linux system and a Windows system; students most commonly use Windows as the client operating system.

ISEGS currently supports four types of questions.

### 1. Flash interactive diagrams:

The two diagrams below show a before and after screen shot of an interactive diagram used in a question about marginal revenue and marginal cost for a monopoly, reduced to fit on the page. Students start with the diagram at the left, and based on numbers provided to them in the question must correctly position the demand, marginal revenue, and marginal cost curves for the monopolized vending machine market at Washington State University.



The exercise goes on to ask students about the profit maximizing response by a monopolist to an increase in its marginal cost. Students manipulate the diagram by using their mouse pointer to move the circle and diamond shaped endpoints of the lines. They measure positions on the vertical and horizontal axis by moving the yellow triangles, called rulers. You can see in the

second panel how the student has positioned the rulers to show the profit maximizing quantity and price. (The numbers are hard to read because I reduced the image.)

ISEGS can score the diagram by checking if the student has correctly positioned the demand, marginal revenue, and marginal cost curves. In this case, the exercise author set up the question to score the intercept and slope of each line independently, so that ISEGS can tell the student what part of an incorrect line position had an error. The author could have chosen to check both the intercept and slope together of each line or all the lines together. A related option only requires students to shift a line left/right or up/down relative to an initial position. ISEGS determines the correctness of a question by comparing the student answer to a computed answer plus/minus a tolerance setting (controlled by the exercise author).

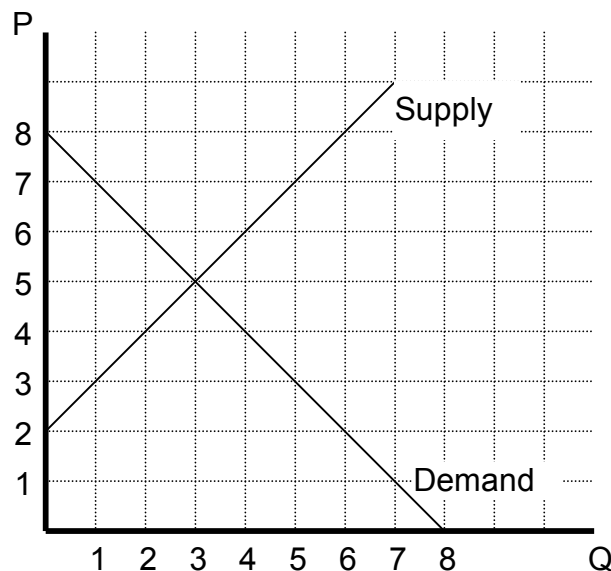
The exercise author can also set up numerical questions that depend on the position of the diagram. Thus, in this example the student may not correctly position the demand curve but nevertheless correctly identify the equilibrium price given the (incorrect) position of the demand curve. In this way the software has a limited ability to mimic what a human scorer might do.

### 2. Numerical answer:

You can see several examples of numerical entry questions in Appendix 1. They look a little different in ISEGS because of a color-coding system for the answer boxes that doesn't transfer to Microsoft WORD. In particular, the input box would have a background color of yellow if the student had not submitted the exercise for scoring since an entry was last saved, a pink background if the input box contains an incorrect answer, and a green background if the input box contains a correct answer. ISEGS scores student answers as correct if the student answer falls within a tolerance value of the correct answer, controlled by the exercise author. Numerical answers can depend on the position of interactive diagrams, as described above, but at the current time cannot depend on other numerical answers.

### 3. Multiple-choice:

Exercise authors can create multiple-choice questions that vary quite considerably across students. Multiple-choice questions traditionally contain three parts: the *stem*, the *distractors*, and the *answer*. I divide the stem into three parts, the *parameters*, the *scene*, and the *prompt*. Consider the example below.



Suppose the city of San Francisco imposes a rent ceiling of \$3 per square foot on the rental market described by the diagram above. We would observe

- A. excess demand of 2 units.
- B. excess supply of 2 units.
- C. excess demand of 4 units.
- D. excess supply of 4 units.
- E. Not selected.

By the *parameters* I mean the numerical values in the question. For example, the size of the price ceiling could equal \$2, 3 or 4 without altering the basic point of the question. Changing the parameters causes the smallest amount of substantive variation across students.

By the *scene* I mean characteristics like the price ceiling taking place in San Francisco, or whether the price ceiling applies to a rental market or gasoline. Authors can create random scenes to make multiple-choice questions appear more unique. Don't underestimate this effect. I have seen groups of students who are struggling to understand each other's questions that only differ along the relatively trivial dimension of market. In the process of figuring this out they learn some valuable lessons.

By the *prompt* I mean the very substance of the question. For example, the above question could consider a price floor, in which case the question asks students to consider the opposite effects from those posed in the example.

The *distractors* and the *answer* can vary across students as long as each question contains only one correct answer and the distractors and answer reflect any variation in parameters, scene, or prompt. ISEGS multiple-choice questions allow authors to specify a set of distractors and correct answers with each student seeing a randomly chosen subset of each. For example, a question could contain 10 distractors and 3 correct answers with the software set to randomly choose 3 of the 10 distractors and 1 of the 3 correct answers for each student.

The example above could represent a realization from a set of different distractors and different correct answers. Each student sees a randomly chosen set of three distractors (the number three chosen by the exercise author) and a randomly chosen correct answer. The student will see the same set of distractors and the same correct answer every time he/she opens the exercise, although the order will change. Once the student has chosen an answer and submitted it for scoring the “Not Selected” option will disappear.

#### *4. Short-answer:*

Exercise authors can create short-answer questions in which students must type text answers to the question, e.g. “Explain the concept of marginal cost.” These questions depend on the instructor or TA for scoring. The instructor and/or TA have a comment box that will appear to students after the instructor completes scoring the answer.

### **Authoring**

ISEGS makes it relatively easy to author exercises; authoring amounts to preparing an HTML and PHP file and putting it in the correct location. You can use any of the what-you-see-is-what-you-get HTML editors, such as Dreamweaver, GoLive, or Frontpage. You can find out much more about authoring exercises in the Author Manual that comes with ISEGS. However, unless you’re the type of person that finds working directly in HTML code appealing, you won’t find authoring ISEGS exercises very interesting.

### **ISEGS To-Do List**

ISEGS makes steady progress adding new features that either assists instructors in managing the system, assist students in coping with the exercises, or adding new question types. You can see below a short list of the major feature additions planned for ISEGS. These represent major feature improvements planned for ISEGS; there exist a large number of more minor changes planned.

*Naturally, in the spirit of open source, I would welcome any assistance on these projects.* Not to mention the never-ending demand for documentation and improvement to the user manuals. The existing manuals exist as a text file in the XML-Docbook format, another open source tool.

1. Improved flash diagram system: The current system for generating interactive flash diagrams provides a good set of controls for exercise authors, e.g. line color, line label, etc. But, a new system currently under development should provide a much more flexible system and use XML strings to define the diagram. Later, these same XML strings can generate SVG diagrams that should fit into printed output in a better way.
2. Revision record: We are currently developing a system to keep records of all submissions by students, not just their most recent submission. (Mostly finished)
3. Equation answer: Another similar program, WSU Q&T, allows students to enter equations as answers. The software then checks the equation for correctness. One of the most important limitations in ISEGS exercises arises from checking only answers and not process. For example, ISEGS has an exercise on the deadweight loss of a tariff. One semester the example exercise had randomly come up with a configuration in which the equilibrium price in the world market equaled the area of the deadweight loss triangle for



consumers. If this configuration arose as an actual exercise for a student and the student did not read the text but looked only at the example (alas this happens) then the exercise can generate a false positive for the question. Asking students to enter equations can go a long way toward eliminating this problem, just like asking students to show their work does on a paper exercise.

4. Print mode: Some instructors would like to produce paper assignments that still present each student with a unique problem. A paper assignment has distinct advantages in reliability and would allow instructors to see the work by students more completely than will ever be possible with ISEGS. Of course, it does face the cost of requiring hand scoring of every answer unless instructors ask students to do it both on paper and on the computer, some sort of hybrid approach. ISEGS will produce an answer key for each unique exercise.
5. Linked numeric answers: Currently exercise authors cannot make one numerical answer depend on a student's answer to a previous numerical answer. Authors can do this with interactive flash diagrams but not with numerical answers.

### **Using ISEGS without Regrets**

Instructors of large introductory economics classes should find ISEGS the most helpful. Compared to giving no graded homework assignments, using ISEGS will increase the workload on instructors who must now field more questions than before and must also cope with claims of software failure. This section provides some tips I have found useful while using ISEGS in my large classes.

Mechanical or network failures will occur. Just like the student whose car won't start on the morning of a big exam, students will encounter problems entering their work and having it scored. For example, the default session time-out for ISEGS equals 2 hours. If students hold a web page open longer than this without activity then they have a chance to lose their session, meaning that when they submit their exercise for scoring ISEGS responds by throwing away their answers and putting up a login page. Other network failures can occur outside the control of ISEGS.

I organize my class in the following way to help students cope with problems. First, I let each student submit his or her assignment twice. ISEGS will keep a record of their previous answer and only scores the answers they previously had incorrect. I tell students that the second attempt exists to let them recover from a machine failure on their first attempt. After a first failure, I also allow students to submit their work on paper in order to remove the risk of failure on the second submission. No students have taken advantage of the paper submission option in several semesters of use.

You can set an open, due and close date for each assignment. This system has an important benefit for instructors and students. Set a due date about two days before the close date. Make sure students understand that you consider the assignment due at some time you specify on the due date (midnight?) but that the computer won't actually close the exercise until midnight of the close date. This gives students some time to sort out any network problems or computer problems they encounter. It also helps distribute the server workload more evenly because

students attempting to meet the due date do not generally wait until just hours from the time you have specified. I generally allow about 48 hours after the due date before the exercise closes. Of course some students will nevertheless wait until just before the close date before attempting the exercise. The background for the exercise link will turn pink after midnight of the due date, so it's easy for students to see when they have moved into the "grace period" before the exercise closes.

Even with the grace period described above, some students will miss work for reasons beyond their control. ISEGS does not provide a way to open an exercise to a subset of students. Such a feature was not part of the original design for ISEGS and would present problems in adding the feature. Moreover, some instructors (myself) prefer a different solution.

Instead of policing excuses I generally prepare more exercises than I intend the students to complete for full credit of the "homework" portion of the class. The extra assignments amount to a flexible makeup system. For example, suppose that I have prepared 1,000 points worth of ISEGS work (i.e. the total points possible if a student correctly completes all the assignments). I will announce in my Syllabus that I only require 800 points worth of work. This allows students that missed an assignment to take advantage of the excess assignment to makeup for the work. It also allows students who missed some questions because of silly (or substantive) reasons to makeup that work as well. I generally allow students to earn extra credit if they do all the work, but I make it clear that the extra work earns extra credit and that I consider students who achieve 800 points (in my example) to have earned an A for homework.

### **Complaint Desk**

Some students will believe that they have missed a question or their work was lost due to a bug or error in ISEGS. As with any software, the possibility of a bug exists. Additionally, the entire system depends on network services and client computer software entirely out of the control of ISEGS or the instructor using ISEGS. Not to mention the incredible diversity of browsers and operating systems.

My school has a public access lab available to students. I make sure the software works in those labs and then recommend students who do not have the proper computer setup to use the computers in the public lab.

Although I have used ISEGS for several years now there remains a small chance of bugs that negatively affect students. The instructor can reduce the impact of any bug by adopting the due and close date and the makeup systems described above, but let's consider the types of bugs that can arise. Bugs can arise in ISEGS in three ways, just like with a traditional paper exercise.

1. Error in the exercise: Exercise author writes a badly specified exercise.
2. Error in the answer key: Exercise author specifies an incorrect answer.
3. Error in the processing: Some error in the processing of the exercise, like a lost paper.

In ISEGS, the first two types of errors arise as author errors in the construction of the exercise specification. The third type of error would arise from a bug in the ISEGS code.

*Error in the Exercise:*

Instructors will find this type of error the easiest to find and fix. Generally it involves some bad wording or inadequate instructions. However, ISEGS exercises present some special difficulties because of their random nature. For example, suppose an instructor creates an exercise asking students to find the equilibrium price in a market in which the supply and demand curves depended on randomly assigned intercepts and slopes. The author may unwittingly select a range of possible values for intercept and slope that occasionally imply an equilibrium price less than zero. For a small number of trials the defect may not show itself, only appearing when a large class begins to work with the exercise.

*Error in the Answer Key:*

The second type of error arises in two ways: tolerance value too small or incorrect answer formula.

*Tolerance:* Exercise authors face a trade off when specifying a tolerance value. A too small tolerance generates false negatives; a too large tolerance generates false positives. The Author Manual provides some guidelines but inevitably the issue requires trial and error to resolve.

*Incorrect answer formula:* Anyone who has passed an algebra class has become very familiar with this type of error. Alas, sometime we just make mistakes in derivations. Of course, we could look at this as an error in the text of the question since the coded formula probably represents the correct solution to some question. In my experience, this error sometimes arises because I change the question and forget to change the answer!

Students sometimes come to me convinced that ISEGS has an error in the answer formula or tolerance. It can happen, but over time these errors disappear so more often than not the error lies with the student. Of course, this represents a teaching opportunity. I require students to show me the complete derivation of their answer, and only then examine their exercise to see if the answer key has an error.

I generally see three types of errors by students: (1) Silly errors, like incorrect arithmetic (don't we all make these mistakes). (2) Substantive errors from incorrectly understanding some important detail about the problem. (3) Inductive errors from using an example to short cut their work. For example, recently the ISEGS exercise on the deadweight loss of a tariff generated an example exercise in which the equilibrium price in the world market equaled the area of the deadweight loss triangle for consumers. Since the total deadweight loss equaled twice the consumer deadweight loss one student entered twice the equilibrium world price as their answer for deadweight loss.

*Error in Processing:*

Errors in the ISEGS code or the network systems that support the code can cause students to lose data or otherwise fail to finish an assignment. This type of error rarely occurs but can't be ruled out; it's also very difficult to determine and correct. The error could exist in the ISEGS code, or it could occur in the web server, anywhere along the network, or in the clients' computer. At this time I am very skeptical of claimed bugs in ISEGS. Before accepting student complaints about a failure in the system the instructor should carefully examine the student logs and consider some of the anecdotes in the Instructor Manual.

To be safe, and allow for network failures, I advise students to keep a paper copy of their answers and click the save button every 30 minutes. Instructors can change the default session limit for students; see the Administrators Manual.

## Appendix 1

### Exercise: Present Value

**Reference:** *ISEGS Study Guide*

**Introduction:** The price of an asset equals the present value of the returns generated by the asset. Robert Goizueta, former president of Coca Cola, used this basic observation to guide a turn-around strategy at Coca Cola. This exercise will help you understand the nature of present value and the price of an asset. You'll need to read about the case study in the *ISEGS Study Guide* to do this exercise.

- Suppose I could earn 5% on an investment of  $P=6.00$ , how much would I have at the end of one year?  
 How much would I be willing to pay in order to receive \$6.30 one year from now? Clearly I wouldn't pay more than \$6.00, which equals  $\$6.30/1.05$ .
- Suppose you own an asset that will pay  $P=9.2$  in  $T=8$  years. Assuming the interest rate equals  $i=8\%$ , the present value of this asset equals
- Find the present value of each of the returns specified in the table below assuming the interest rate equals  $i = 15\%$ .

Future Value	Years in future	Present Value
\$79.81	1	<input type="text"/>
\$79.81	2	<input type="text"/>
\$79.81	3	<input type="text"/>
\$79.81	4	<input type="text"/>

- Suppose you owned an asset with the payoff stream described by the above table. The present value today of this asset equals the present value of all the returns in the future, in this case
- Some assets, like certain types of Bonds, pay the same amount forever. We know in the real world those assets don't sell for infinite dollars, but doesn't our formula for asset value imply infinite value? No. To see why, notice in the above table how the present value of each future payment gets smaller and smaller. To what present value does the above asset get closer and closer to as we add more and more years to the return stream?

6. Suppose you believed that a share of XyZ Corp would generate sales and dividends according to the following table.

Year	Sales	Dividends
1	58.16	5.82
2	57.90	5.79
3	11.05	1.11
4	11.42	1.14

7. If you expect to sell a share of XyZ Corp in the fourth year for \$220 and assume a discount rate of  $i = 13\%$  then you should be willing to pay  for the share.
8. Now suppose that the interest rate on government securities drops by two percentage points. You should pay because of the interest rate change, you should pay about
9. Consider AbC Corp. with a book value of \$46.70 million and paying 8% in dividends. If other firms in the same risk class as AbC Corp. paid 11%, what market value would you expect to find for this firm?  
 Million
10. Suppose another management team took over AbC Corp. and through better management can pay the market competitive rate of return in dividends. By how much should the market value of AbC Corp. increase?
11. Suppose management at AbC Corp. receive compensation in the form of stock options proportional to the change in market value for AbC Corp. By increasing the rate of return in dividends from 8% to 11% management should expect to increase its compensation by  %

## Exercise: Opportunity Costs

Reference: *ISEGS Study Guide*

**Introduction:** The *ISEGS Study Guide* explains how opportunity cost depends on net benefits of alternative opportunities; this exercise will help you work your way through some of the basic concepts.

1. Consider the following table showing the willingness to pay for several goods and the actual price at which they are sold. For each good determine the consumer surplus of consuming one unit of each good.

	Good 1	Good 2	Good 3	Good 4
Willing to pay:	6.00	8.00	9.00	9.00
Market price:	6.00	5.00	7.00	5.00
Consumer surplus:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

2. Each of the goods have a different price so if someone purchased Good 1 instead of Good 3 then they would have \$1.00 left to spend on something else. Let's ignore this left over money and simply look at the opportunity cost of choosing to buy just one good.<sup>1</sup> In each cell below, supply the opportunity cost of buying the good. That is, in the first cell enter the opportunity cost of buying good 1 and not any of the other goods. In cell two enter the opportunity cost of buying good 2 and not buying any of the other goods. Etc.

	Good 1	Good 2	Good 3	Good 4
Opportunity cost of consuming one unit:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

3. Suppose someone offers you a choice of Goods 1 through 4 as a gift. What does the opportunity cost of each good equal in this case?

	Good 1	Good 2	Good 3	Good 4
Opportunity cost of choosing a gift:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

4. Now suppose you have \$1,050 to spend on one of the types of goods, 1 to 4. For example, you can buy up to 210 units of Good 2 or 150 units of Good 3. Complete the table below with the opportunity cost of spending the entire \$1,050 on a single good.

	Good 1	Good 2	Good 3	Good 4
Opportunity cost of spending \$1,050 on one good:	<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>

**Appendix 2**

1. (2pts) Suppose you could buy an asset that pays \$98.07 per year forever? What is the maximum you would be willing to pay for this asset if the market rate of return for this type of asset equals 8%? \_\_\_\_\_
2. (4pts) Suppose you believe that a share of XyZ Corp will generate sales and dividends according to the following table. If you expect to sell a share of XyZ Corp in the fourth year for \$220 and assume a discount rate of  $i = 8\%$  then the maximum you would be willing to pay for this share equals \_\_\_\_\_.

Year	Sales	Dividends
1	88.24	8.82
2	17.85	1.79
3	57.82	5.78
4	92.23	9.22

3. (5pts) The current market value for AbC Corp. equals \$33.28 million and it pays a normal 11% market return rate for this type of investment. Suppose new information reduces the public's assessment of risk for AbC Corp. so that investors will accept an 8% rate of return. By how much does the market value of AbC Corp. change?  
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4. (4pts) Use the following table

		Good 1	Good 2	Good 3	Good 4
	Willing to pay:	12.00	5.00	13.00	5.00
	Market price:	9.00	3.00	8.00	4.00
A	Opportunity Cost of purchase:				
B	Opportunity Cost of gift:				

For this problem put the opportunity cost of buying one unit of each good, ignoring the value of any money left over, in row A. Put the opportunity of choosing one good as a free gift in row B.