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# Flipping the College Spreadsheet Skills Classroom: Initial Empirical Results

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## ABSTRACT

There is an enthusiasm about the flipped classroom method, the teaching approach that requires the students to learn by watching a lecture video as homework, and doing the application exercises when they report to class. This preliminary research compared the aggregate homework scores of 20 assignments between the traditional lecture group (N=55) and the flipped group (N=70) in an Excel class taught by the same instructor. The t-test indicated that the difference in mean scores between the two groups was not statistically significant. The students' comments in the flipped class suggested that students with prior knowledge about the software or those who easily learn new computer skills did well in the assignments without watching the videos. However, the students who lacked the prior knowledge, or lacked the confidence, benefited from watching the videos. This result implies that instructors can refer to students' prior knowledge and the difficulties of the content in order to decide which part of the class to flip. It also indicates that flipping the class is not always superior to the traditional lecture approach. This study builds upon previous works by providing a empirical data that explores whether flipping the classroom is an effective method of teaching.

**Keywords**: *flipped classroom, inverted classroom, Excel, spreadsheet skills, undergraduate education*

## 1. INTRODUCTION

In an average lecture-based course, the instructor teaches to the 'middle of the class.' Some students need the same explanation repeated to understand the content and some students can quickly grasp the concepts and move on. Adjusting the presentation speed to each student is not likely to occur nor possible. The flipped classroom, or inverted classroom method, promises to solve this problem. In this approach, students watch a lecture video prior to reporting to class[1]. Students can pause the video or repeat the video segment that they did not understand, and proceed at their own speed[2,3]. Students who participate in the flipped approach come better prepared for class; students tend to be more engaged in class, and as a result learning is increased[4,5,6] Researchers have also created their own lecture videos and made them available for students. The students responded positively that they could pause and rewind the lectures as they take notes[7].

This study reports on an experiment of the flipped classroom in a spreadsheet skills course through the use of video recordings provided by the textbook author that demonstrate spreadsheet techniques, concepts, and skills. This paper focuses on whether using the flipped classroom to teach spreadsheet skills actually increases student knowledge and understanding, and shares student reactions related to the flipped classroom after participating in this learning experience. Since instructors' pedagogical skills and content knowledge are major components of a successful flipped classroom, comparing both approaches taught by the same instructor and using the same textbook, will make a significant contribution to the field.

## 2. MOTIVATION

There are three main motivations for performing this experiment: 1) student satisfaction with the speed with which the concepts are taught, 2) instructors wishing to spend less time teaching the "how to" skills and more time teaching the application of the skills, and 3) to empirically test whether flipping the classroom is effective for a spreadsheet skills course.

Many students in a software skills course can feel the progress of the class as a whole is too slow or too fast, due to a diverse background knowledge. For those who feel the pace of the class is too slow, listening to the lecture can be boring and feel that they are a waste of time. For those who feel the pace of the class is too fast, on the other hand, it can be a struggle to keep up and learn the concepts and skills. Additionally, many students want to review the materials more to increase understanding before doing homework on their own or attempting an exam.

A common complaint among instructors is the time they must spend teaching the "how to" skills instead of using that time to teach the application of those skills. If the flipped classroom method is effective, then the instructors could focus on the application of the skills in solving business needs.

This study endeavors to empirically examine the effectiveness of the flipped method in teaching and learning, and confirm whether or not the students prefer the flipped approach.

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## 3. RELATED WORKS

The flipped classroom has become popular in secondary and higher education for teaching various courses[8]. Recently during the 43rd ACM technical symposium on Computer Science Education a plenary session was conducted to discuss and share which flipped techniques work and discover whether flipped classrooms improve success and retention[9]. Pierce and Fox indicated that pharmacy students found viewing lecture videos prepared them for class activities, and they enjoyed viewing the lecture videos[10].

Although the flipped classroom method is becoming popular, there is also the argument that flipping does not automatically make a poor teacher a good teacher. There are still pedagogical decisions to be made, such as which portion to flip, which activities to follow up on, and how to adjust instruction to the individual needs of learners[7]. Also, the instructors' ability to make meaningful connections between the videos and the class activities may be a critical element for the students' positive attitude about the flipped method[10].

In addition, flipping would not be successful unless learners are committed to viewing the homework video. Because students who do not want to have ownership in their learning tend to resist the flipped method, instructors need to have a system to hold students accountable by having the students show notes[7] or administering a short quiz based on a video, including details about the presenter to ensure that the students watched the video[11,12].

While more studies are being conducted, there is a need for more research into the flipped pedagogy in higher education[13]. This study builds upon previous works by providing an empirical data that explores whether flipping the classroom is an effective method of teaching.

## 4. OUTLINE OF STUDY

### 4.1 Demographics of Target Population

The study population was comprised of students in a rural university in the Eastern United States. Students in several majors must take the course in which spreadsheet skills are taught. While the ethnicity for the four sections of the course in this study was not available, 70% of participants were male, and 30% were female. The participants included students from the following majors: Exploratory, Art, Accounting, Health Services Administration, Finance, Economics, Undeclared, Management, Information Systems, Health Sci-Public Health, Mathematics, Computer Science, Safety Management, Information Technology, Chemistry, Marketing, Psychology, Accounting, Communications - Emerging Technology & Multi-Media, and Safety Management (see Figure 1). This combination of majors provides a good mix of students with differing abilities with MS Excel, the spreadsheet taught in a productivity software skills course.

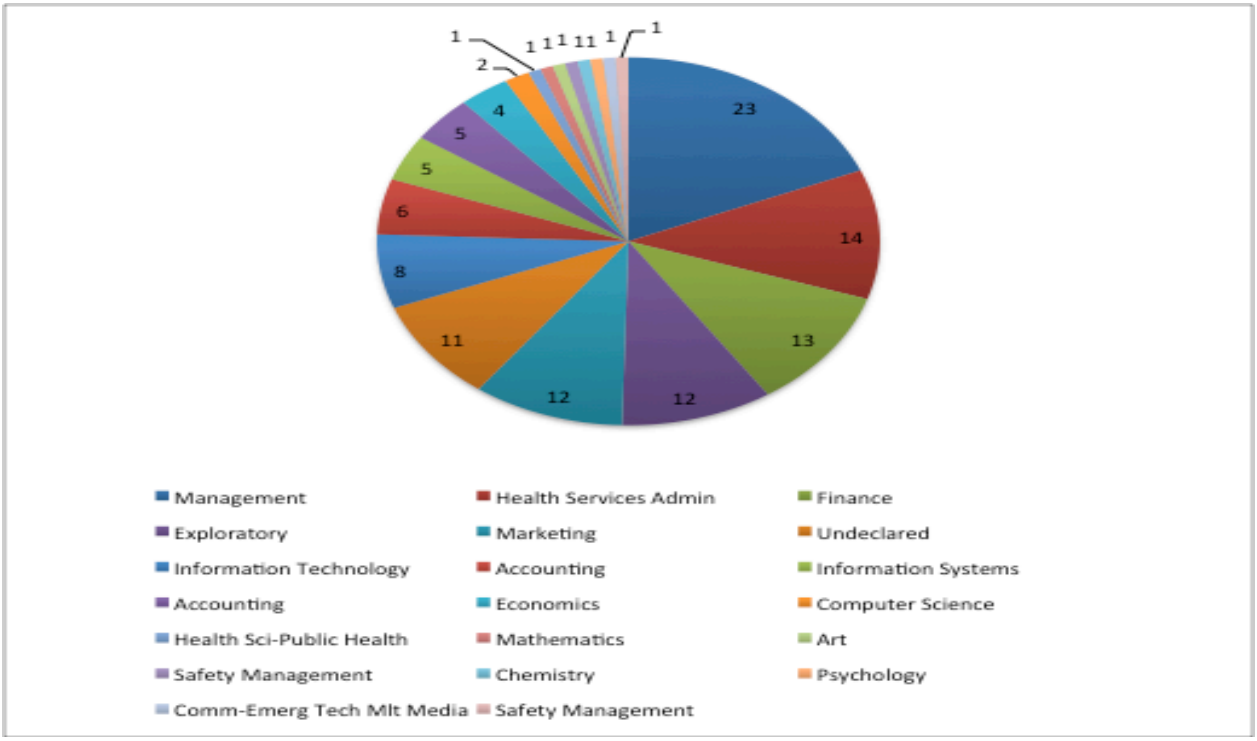


**Fig 1:** Majors Represented in Four Sections of Course

### 4.2 Research Methodology

The study population came from four sections of the productivity software skills course. The students in the sections were self-selected; students signed up for the course and section according to their schedule and needs. Most students take the course during their freshman or sophomore years.

All four sections of the course were taught by the same instructor who used the same version of Excel and the same textbook – Microsoft Office 2007 In Business, Core (with Student Resource DVD) by Joseph J. Manzo and published by Prentice Hall. The DVD accompanying this textbook contained not only the data files used in the examples and assignments, but a video for each task that explains how and why each task is done.

Two sections of the course (55 students) taught in the spring term of 2012 were the control group. These students were taught the traditional way; the instructor taught the "how to" methods in class, and assigned homework to the students to do on their own. Another two sections of the course (70 students) taught in the fall term of 2012 were the test group. These students were taught using the flipped method, in which they were assigned to follow the steps outlined in the text and watch the accompanying videos to learn how to accomplish each task. Then in class they worked on the homework assignments, getting help from each other and the instructor when needed. A sample lesson and subsequent homework is included in Appendix A.

In the control group, students report to class to listen to the instructor, who demonstrated and explained how to complete tasks and why they do what they do. In the study group, the students had the option to watch the videos that the textbook publisher produced. Students in this group then had the option to complete tasks on their own or report to class to ask questions and to complete the tasks with the assistance from peers and the instructor. This study empirically determines whether the flipped classroom is effective for a software skills course.

### 4.3 Research Question 1

Is flipping the classroom a more effective method to teach spreadsheet skills than the traditional lecture method? This study uses the aggregate score of 20 spreadsheet homework and in-class assignments to measure effectiveness.

### 4.4 Hypothesis

H0: There is no statistical difference in spreadsheet skills between the traditional lecture-based class and the flipped classroom as measured by scores on homework and in-class assignments.

### 4.5 Data Collection

The data collection was accomplished during the normal conduct of the course. There were two sections of the traditional lecture class and two sections of the flipped class. The same instructor taught all four sections of the course, and the students completed the same assignments, which were graded using the same rubrics.

### 4.6 Analysis Method

This research employs descriptive statistics and a t-test to compare the means of the aggregate homework and in-class assignment scores between the lecture-based class and the flipped class. Rogers explained that when analyzing data from assessments, "[i]n most cases, descriptive statistics is all that you need to use. … generally, sophisticated statistical analysis is not required"[14]. Similarly, Rigby, et al explained that when analyzing data from assessments, descriptive statistics could be used to assess the efficacy of different instructional strategies [15]. Following their lead, this study will use descriptive statistics and a t-test to analyze the data.

### 4.7 Research Question 2

Do the students in the target population prefer the flipped classroom method? To measure the students' preference, a three-question-survey was administered.

### 4.8 Data Collection

At the end of the term, the students in the experimental group were asked to take a short survey to gauge their perception of the effectiveness of flipping the classroom. There were 61 anonymous responses (out of 70) to the following survey questions:

a. Did you like doing the "how-to" exercises as homework to learn how to accomplish a specific task and then doing the "homework" exercises in class? Why or why not?
b. When doing the homework, did you use the videos (even once)? Why or why not?
c. If you used the videos for the homework, do you believe they helped you achieve a better understanding of how to accomplish the task? Why or why not?

### 4.9 Analysis Method

For research question 2, student answers were categorized for "yes" and "no" and classified by the patterns of positive and less positive comments. If the students liked the flipped classroom method, the researchers checked if they used the videos or not. In order to minimize each researcher's bias, the researchers in this study independently looked for patterns of positive and less positive comments. Differences in the interpretations of the comments were resolved through discussions.

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# 5. RESULTS AND DISCUSSION

## 5.1 Research Question 1

An independent-samples t-test was conducted to compare the aggregate scores of assignments between students in the traditional classroom and those in the flipped classroom. The differences in means were not statistically significant. The mean of the traditional lecture scores was 1087.09 with a standard deviation of 291.01. The mean of the flipped classroom scores was 1032.89 with a standard deviation of 238.74. The t-value was 1.14 with df=123 and p=.26. The result failed to reject null hypothesis.

When a t-test is performed, there is always a possibility of Type I error – rejecting hypothesis when it should not be rejected, and a Type II error – failing to reject null hypothesis when it should be rejected [16,17,18]. Therefore the researchers calculated power. Power indicates the likelihood of rejecting false null hypothesis [18] and a value greater than .8 is expected to be dependable [16]. The power in this study was only 0.20, indicating a high probability for Type II error.

## 5.2 Research Question 2

As mentioned in the related works section, the students who take the initiative to learn tend to have positive attitudes and those who expect to be provided with knowledge or information in an oversimplified way tend to dislike the flipped classroom method. This research aimed to find out if the target population follows the same trend.

There were61 responses (out of 70) to the short survey to gauge students' perception of the effectiveness of flipping the classroom.

For survey question one, 55 students (90%) answered affirmatively. This suggests that the majority of the students would prefer to learn using the flipped classroom method. The affirmative answers showed the following pattern (sic):

**Being Prepared for the Class Exercises:**

"Yes, doing them for homework was a challenge and almost an intro, then when we went to class it was kind of like putting the pieces of the puzzle together from what we did for homework to complete our understanding of the topic."

"Yes, I thought it was very helpful doing the "how-to" exercises before doing the homework exercises in class. It made it easier to do the in class homework in class after we had done the 'how to" exercises.

**Step by Step Direction:**

"yes, They give you step by step instructions and I can go at my own pass [pace]. I am to [too] slow to go along with the class. Also the homework and especially the skills exams are very hard so I would prefer to do these in class."

**Better Understanding of the Material:**

"Yes, doing stuff before class that we then go over solidifies what we learned in the homework, and we can ask questions/learn what we didn't understand in the homework.

**The Negative Answers Showed the Pattern Below:**

Preference mode:

"No, I prefer doing them in class, because it is easier and less frustrating to comprehend them while being discussed out loud."

Pacing in the class:

"Sort of, I did not like when kids in the class and no idea what they were doing but I did so I could have done it a lot faster."

Naturally, the frustration at having to help or wait for classmates who have not acquired the skill yet still exists; as does the frustration felt by the students struggling to acquire the skill. This is to be expected, as everyone learns software skills at a different rate. While the survey results suggest that students embraced the flipped classroom instructional model, the empirical results did not show a significant improvement in scores, suggesting that, contrary to other studies, this instructional method is no better than the traditional classroom.

For survey question two (did you use the videos; why or why not?), 34 students (56%) answered yes to the first part. This suggests that more than half of the students who liked the flipped classroom used the videos to help learn the material.

The reasons for using the videos included (sic):

**Deep Understanding:**

"Yes, I used the videos for almost all of them. The step by step process was helpful and allowed me to understand meaning behind each step."

Used on tasks they could not figure out on their own:

"Yes, I used the videos a few times, not every time. Mostly on the activities I did not know how to complete. I don't think I used the videos on the tasks that I felt were simple."

The reasons for not using the videos were sufficient prior knowledge or the efficacy to acquire new skills. The comments that fell into this trend included:

"I didn't use them because I already knew how to do it or I figured it out on my own."

"No, Never. I did not need them to understand the assignments."

For question three (did the videos help you; why or why not?), 30 students (49%) answered affirmatively. While only slightly more than half the students used the videos, the comments of those who did found the videos to be very helpful. This suggests that in addition to learning the "how to" of each skill, having a video to watch reinforces the concepts and enhances learning.

The patterns that represented the affirmative answers were (sic):

**Match with the Preferred Mode of Learning:**

"When I did use the videos they did help a lot, they helped so I could watch what was going on opposed to reading it. I learned better this way."
"I am a more visual learner so it helped to see what to do instead of reading it."

**Thorough Explanation:**

"When I used the video it did help me to complete tasks more efficiently and step by step process which broke down instructions into a way I could understand it."
"Yes. They showed me step by step and it was easier for me to follow."

Deep Understanding:

"Yes, having the videos explain why I was doing some of the things that I was doing (especially in Excel) helped it make more sense.

The reason for finding the videos not helpful was that the students already had the skill. One student stated, "The only video I watched, I already knew how to do the task, so it was just redundant information for me."

Of the 55 students who liked the flipped classroom, 27 students also used the videos and believed the videos helped them learn the material, while 24 students liked the flipped classroom, but did not use the videos. Only four students liked the flipped classroom and used the videos, but didn't believe the videos helped them learn the material.

Four students didn't like the flipped classroom and didn't use the videos (hence the answer to survey question three was "no". Surprisingly, only two students didn't like the flipped classroom, but they did use the videos and believed the videos helped them learn the material.

## 6. CONCLUSION

This study compared the aggregate scores of assignments in Excel spreadsheet skills between two groups. Two sections of the traditional lecture class formed the control group (N=55), and the experimental group consisted of the students in two sections of the flipped class (N=70). The t-test in this study failed to reject null hypothesis, with p=.26. It indicated that the difference in the mean aggregate score between the two groups was not statistically significant. However, post hoc computation of power was only 0.2, implying the need for larger sample size to decrease the probability of Type II error.

The trends of the comments explain the result of the t-test, which failed to reject the null hypothesis. Many students had prior knowledge of topics in the class and they found the tasks easy. Students with prior knowledge or the ability to figure out how to use software on their own did not find the videos useful. The students who had high efficacy liked finishing the assignments on their own. They did not enjoy the class when the pace of the class was slow to them. On the other hand, the students who needed visual instruction had favorable view of the video instruction. This is in agreement with Todo and Nguyen'sstudy that showed visual students favor learning with videos[19]. Students without prior knowledge appreciated being able to follow step-by-step instructions.

## 7. FUTURE RESEARCH

The homework assignment scores were aggregated to determine whether flipping the classroom is an effective method for teaching spreadsheet skills. The comments indicated that the students did not need to watch the videos when they perceived the tasks to be easy. It is, therefore, possible that the scores are similar on easy tasks but different on difficult assignments. Therefore the authors would like to examine this phenomenon more granularly by checking each task or skill individually. This is likely to help the instructor determine which part of the class should be flipped and which part should be taught in the traditional lecture method. The authors also plan to study other parts of the course to determine whether flipping the classroom could be appropriate for the word processing and database portions.

Furthermore, post hoc power calculation for the t-test, which yielded $\beta$=0.2, indicated high probability of Type II error. Hence, the research with larger sample size needs to be conducted.

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Stephen Larson teaches Information Systems in the Computer Science Department of the College of Business, Information, and Social Sciences at Slippery Rock University of Pennsylvania. In addition to an MS in IT Management and a PhD in Business Information Systems, he has nearly 20 years experience in the IT/IS industry and has been teaching in one capacity or another since he was 20 years old. He is a reviewer for several IS conferences and journals, and reviews book chapters as well.

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# APPENDIX A

**Sample Lesson and Subsequent Homework**

After teaching the concepts and principles of using the future value function to calculate the value of investments over time, the following hands-on tasks are performed.

**The Construction of the Future Value Function**

(Open the file named ib_e03_thetimevalueofmoney.xlsx before starting the following tasks.)

**1. Data Entry (video)**

a. Activate the Periodic Investment worksheet.
b. Type the following values into the cell locations listed:
cell B2: .08 (this is the annual interest rate)
cell B3: 3 (this is the number of periods an investment is added to an account)
cell B4: 10 (this is the value of payments that are added to an account)
cell B5: 1 (this indicates the payments are made at the beginning of the period)
c. Format cell B2 to a percent with 1 decimal place and then format cell B4 to US currency with 2 decimal places.

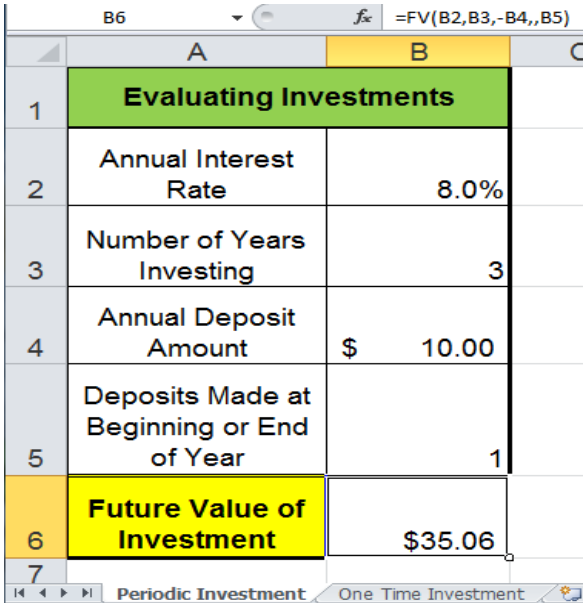
**2. Calculating the Future Value of a Periodic Investment (video)**

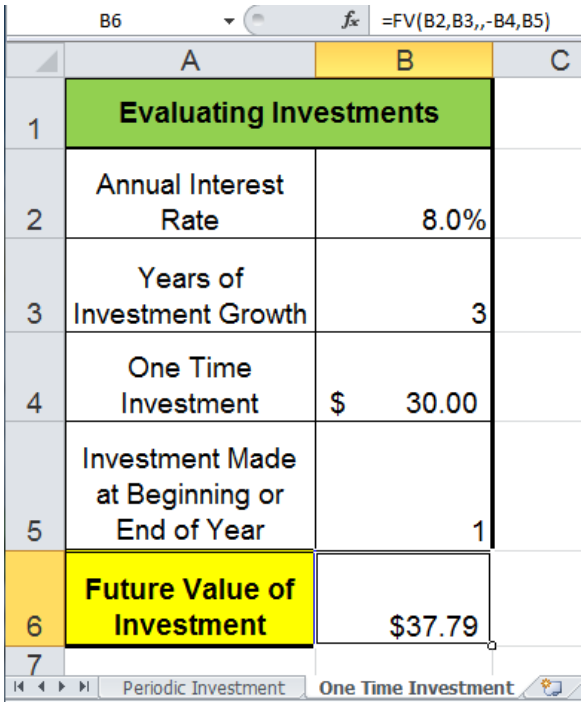
a. Type an equal sign in cell B6, followed by the function FV and an open parenthesis.
b. Click cell B2 and type a comma.
c. Click cell B3 and type a comma.
d. Type a negative sign.
e. Click cell B4 and type a comma.
f. Type another comma.
g. Click cell B5 and type a closing parenthesis.
h. Press the Enter key.

**3. Calculating the Future Value of a One-Time Investment (video)**

a. Activate the One Time Investment worksheet.
b. Type an equal sign in cell B6, followed by the function name FV and an open parenthesis.
c. Click cell B2 and type a comma.
d. Click cell B3 and type a comma.
e. Type another comma.
f. Type a negative sign.
g. Click cell B4 and type a comma.
h. Click cell B5 and type a closing parenthesis.
i. Press the Enter key.
j. Save and close the file.

**Solutions for parts 2 and 3:**



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After class, the following homework is assigned for the students to do on their own:

1. Open the file name ib_e03_skillsexam
2. Use the Future Value function in cell E21 to calculate the future value of all investments in two years. Your function should use cell D9 for the rate and the number 2 for periods. The total present value for all investments in cell C9 should be treated as a one-time lump sum investment. Assume that this investment is made at the beginning of the year. Format the result to US currency with 0 decimal places.

**Solution:**

E21 =FV(D9,2,,-C9,1)

| | A | B | C | D | E |
|---|---|---|---|---|---|
| 13 | Annual Interest Rate | Repayment Years | Principal | Monthly Payments | |
| 14 | 4.50% | 30 | $5,000,000 | $25,334.27 | |
| 15 | | | | | |
| 16 | Lease Details for Vehicles | | | | |
| 17 | Annual Interest Rate | Time of Lease in Years | Present Value of Vehicles | Future Value of Vehicles | Monthly Payments |
| 18 | 2.50% | 4 | $200,000 | $80,000 | $2,796.35 |
| 19 | | | | | |
| 20 | **Financial Summary** | | | | |
| 21 | Future Value of Investments in Two Years | | | | $16,721,370 |
| 22 | Two Year Change in Investments | | | | $1,743,870 |
| 23 | Two Years of Mortgage Payments | | | | $608,022 |
| 24 | Two Years of Lease Payments | | | | $67,112 |
| 25 | Investment Gains Less Mortgage and Lease Payments | | | | $1,068,735 |

Starter Exam Key