MATH 189 Project 2

Group 29

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1 Introduction

For years, the population of students who enroll in statistics classes have been steadily increased based on different kinds of reasons including satisfying the quantitative reasoning requirements. Upon until now, over 3000 students each year choose to take elementary statistics classes, which is a quiet large amount of people. Meanwhile, the acceptance of modern technologies makes the video games popular among students, which even seem to be part of students' daily lives just like studying. In attempt to improve the experience of studying, a series of lab has been designed by the faculties and students who enroll in advanced statistics classes. To be more specific, under the popularity of modern technology, we want to explore how to best utilize those technologies to benefit the students.

The general questions will be separated into 6 scenarios: the first one is giving the interval and point estimates for fraction of students who play videos games during the week before giving questionnaire; the second one includes checking the relationship between the time consumed on play video games on the week before survey and the reported frequency of play, as well as whether there exist exams during that week; the third is making interval survey of the average time spent on playing video games during the aimed week; the fourth is exploring students' different attitudes towards playing video games and the reasons behind them; the fifth one is exploring the differences between those who like and those who dislike playing video games. THThese five scenarios can reflect the students' frequency of playing video games according to their different attitudes based on different behind reasons. Furthermore, as additional research, the grades which in some extent reflect students' situations of studying can also be considered as a new scenario. Through exploring how the expected grade and target distribution in grade assignment, we can find out whether the picture will be changed if those non-respondents who are failing students no longer bothered to come to the discussion section.

2 Data

The first data set video.txt used in the research was collected from the survey conducted in the intro statistical class in the university, and there were 91 observations in the data set. It recorded 15 columns. and they were:

Time: number of hours played in the week prior to survey (continuous variable)

Like to play: 1 = never played, 2 = very much, 3 = somewhat, 4 = not really, 5 = not at all (discrete variable)

Where play: 1 = arcade, 2 = home system, 3 = home computer, 4 = arcade and either home computer system, 5= home computer and system, 6 = all three (continuous variable)

How often: 1 = daily, 2 = weekly, 3 = monthly, 4 = semesterly (discrete variable)

Play if busy: 1 = yes, 0 = no (discrete variable)

Playing educational: 1 = yes, 0 = no (discrete variable)

Sex: 1 = male, 0 = female (discrete variable)

Age: Students age in years (discrete variable)

Computer at home: 1 = yes, 0 = no (discrete variable)

Hate math: 1 = yes, 0 = no (discrete variable)

Work: number of hours worked the week prior to the survey(continuous variable)

Own PC: 1 = yes, 0 = no (discrete variable)

PC has CD-Rom: 1 = yes, 0 = no (discrete variable)

Have email: 1 = yes, 0 = no (discrete variable)

Grade expected: 4= A, 3 = B, 2 = C, 1 + D, 0 = F (discrete variable)

The major variables used in this study were "Time", "How often", "Like to play", "Sex", "Work", "Computer at home" and "Own PC". The number of hours played in the week and the frequency combined could form a clear pattern of students' habits of video playing. Multiple factors were able to impact the time length of video playing. Whether a student like to play usually affected the time they spent on the video games. It was an internal factor. When they liked to play, they were more likely to take more time on the video games. Biological physical structure might as well influence the attitude towards the video games, and therefore changed the time of video playing of the individual. Other possible external reasons could be that they had more or less leisure time which related to their working time length; they did or did not have a home computer or personal computer differed the accessibility of video games. What was noticeable here was that PC has CD-Rom increased the personal computer's video game accessibility and its attractiveness. "Have email" correlated to the profession of the students using computer. People who had an email tended to be more familiar with the computer and had a higher possibility to play video games. "Like math" directly impacted the students' course performance. When they were not willing to pay much time on the lecture, they had more free time for doing other things and one of the possible things could be to play video games. "Grade expected" could reflect students' course performance and expectations. Thus, when they had high-grade expectations, they might put more effort into studying and less time doing other things like playing video games. Some smart statistical students might also love to play some types of game; they might found it was easy to get high scores in the course, so they had more leisure time to play video games. "Play if busy" implied that some students played when they had other things to do, which could include study. It had a negative impact on their course performance and prolonged their playtime in the week. For "Age"elder people tended to have more control over themselves. Thus, they might have higher grade expectations and less video playing time. "Play educational" could positively influence the grade expectations. It was also influenced by the time length of video playing.

The second dataset videoMultiple.txt was also collected from a survey conducted by senior students in an intro statistical class in the university. It is provided by professor Jelena Bradic.This dataset contains 21 variables and 91 observations. They are all discrete variables. Categorical variables include "action" (like action game or not), "adv" (like adventure game or not), "sim" (like simulation game or not), "sport" (like sport game or not), "strategy" (like strategy game or not), "relax" (like playing games for relaxation), "coord" (like playing games for eye/hand coordination), "challenge" (like playing games for challenge), "master" (like playing games for sense of mastery), "bored" (like playing games for avoiding being bored), "other" (like playing games because of other reasons), "graphic" (like playing games for graphic/realism), "time" (don't like playing games because it wastes time), "frust" (don't like playing games because it is frustrating), "lonely" (don't like playing games because of a sense of loneliness), "rules" (don't like playing games because it has too much rules), "cost" (don't like playing games because it costs too much), "boring" (don't like playing games because it is boring), "friends" (don't like playing games because friends don't play), "point" (don't like playing games because it is pointless), "other2" (don't like playing games because of other reasons).

In our research, we used 19 out of 21 of the variables in this dataset. The first five variables, from "action" to "strategy", describe types of video games students like. We use this in responding to scenario 6, where we investigate whether students' preference to a specific kind of game influence their grade expectation. We used the sixth to tenth variables and twelfth variable to investigate whether different reasons for favoring video games contributes to different level of "like" rate. We use the thirteenth to twentieth variables to conduct a sub-research to find whether different reasons for disliking video games contribute to different level of "dislike" rate.

3 Background

As the video games have been increasingly accepted by students based on the improvements of modern technology, people start to consider how to harmonize such unavoidable novel products with students' daily lives, especially when considering their effects on students' studying. Normally, many people believe the video games are more likely to impose negative influence on students' studying grades, as they can distract students' concentration. However, as each activity always has two sides, with deeper researches, more and more scientists recognize the beneficial influence of video games.

According to the research report "Students' attitudes towards playing games and using games in education: Comparing the Scotland and the Netherlands" composed by Thomas Hainey et. al. in 2013, students themselves actually believes playing video games can contribute to their study even under different backgrounds and different ways of receiving educations. They propose that different skills can be trained during playing video games such as competitions and cooperation and they can enhance leisurely experience. This idea can be further strengthened by the "Table: Classification of five main types of video games". As different video games requires different abilities based on their own types, students can build and enhance different abilities while playing video games. Hence, applying the "classification table" in designing better discussion, faculties can mix those different kinds of video games in the education to help students form different abilities. Students can positively enhance their abilities by those attractive products mixed with hard studying. Therefore, actually playing video games can benefits students' education based on their own minds.

Furthermore, the research report "When Play Works: Turning Game-Playing into Learning" accomplished by Brittany Steiner, Nancy Kaplan, and Stuart Moulthrop proposes that designing games can actually be beneficial to students' learning. The idea here is that giving projects of game-designing can enhance students' ability of problem-solving. Meanwhile, as many students consider designing games as a method to show their mind, they can display their creation during modifying the games. Their interesting could probably be triggered promoting them to learning more skills in attempt to finish their own opuses. Hence, actually both playing and designing video games can potentially contribute to students' education. Therefore, instead of excluding such nearly unavoidable modern products in students' daily lives, it may be more reasonable to hold deeper research which can offer assistance to figure out how to maximize the benefits of incorporating videos games in students' education.

4 Investigation

4.1 Scenario 1

In this section, our goal is to provide both a point and interval estimate on the percentage of students who played video games in the week prior to the survey. We used the dataset video.txt. We obtain the number of students who played video games in the week prior to the exam by counting the observations with the variable time not equal to 0, and this number is 34. The time variable equal to 0 indicates that the observation did not spend any time playing video games prior to the survey. Then other observations would be students who did spend some time on video games.

The point estimator for population proportion is the sample proportion. We obtain the sample proportion by dividing the number we obtained above by the total size of our sample. According to the data from video.txt, the population proportion estimate based on our sample is 0.3736264.

After obtaining the point estimator, we need to find the standard error in order to find a confidence interval containing the true proportion. The variance is calculated by multiplying the sample proportion of students who did play and the sample proportion of students who did not. We then take a square root of the variance to get the standard deviation. Thereafter, we divide the standard deviation by square root of sample size minus one to get the first part of standard error. The second part is to take the square root of the difference between population size and sample size over the square root of population size. This step aims to eliminate bias in computing. We multiply the two parts to get the standard error. Then, we find the z-score of 95 percent confidence, which is 1.959964. Thus, the 95 percent confidence interval for the population proportion of students playing video games in the week prior to the exam is (0.2752086, 0.4720442). This interval is obtained by adding and subtracting the product of the z-score and standard error to the point estimate, which is the sample proportion of our sample. This interval means that we are 95 percent confident that the true population parameter is between 0.2752086 and 0.4720442.

This estimate generate from the sample in video.txt indicates that almost half of the students who played video games in the week prior to the survey. In fact, the number might be underestimated if we use our result to estimate the proportion of students who play video games. The reason is that some student who actually play video game regularly might not play in the time period we focus on. Larger amount of student playing video games would increase the practicability of our study, since it means students who play video games would be more representative to the entire student population. This would mean that we are able to study students preference in discussion labs by studying the habits and preference in video game playing. The information and conclusion we get from this research would be applicable to designing new discussion labs for the student population.

4.2 Scenario 2

This section aims to find the relationship between the time playing video games and the frequency of play, and by estimating this relationship, we attempt to design the discussion properly.

We first clean up the data. For the variable time played the week before the exam, there exist some outliers. Besides the value 99 is an obvious outlier, two special values are much bigger than the normal value, which are 14 and 30. The person who answered 30 only play games weekly, so I believe it's a mistake when filling the survey. For two people who answered 14 hours, they play the game daily, which is doable if they play two hours every week.

4.2.1 Method 1: Summary statistics

We first look at the data of the time played in the past week and the data of the frequency to get some general information about the data.

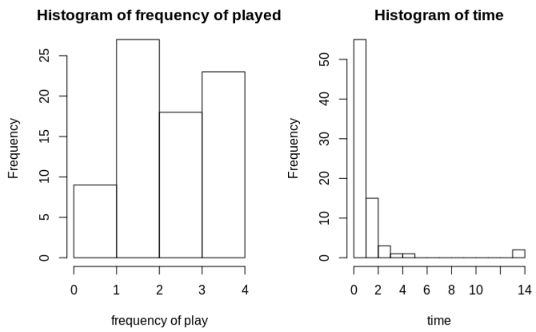
For the time played in the past week, it has a mean of 1.08 hours with a variance of 5.72. It has a skewness of 4.15, so it is highly skewed to the right. Its kurtosis is 19.2822, which indicates it has a very strong peak.

For the data of the frequency of the gameplay, it has a mean of 2.71. Therefore, its mean is between 2 and 3. As we know 2 indicates playing games weekly and 3 monthly, so the mean frequency is somewhere between weekly and monthly. The skewness of the -0.071, and the value is relatively small, and we can consider the distribution of the data to be very close to symmetric. It also has a very small kurtosis, -1.26, which indicates its peak isn't so strong.

The frequency of play and time played have very different distribution. From the data, we know that an average person who took the survey plays the game around 1 hour every two weeks. However, the exact distribution of the two needs further examination.

4.2.2 Method2: Histogram

We plot histograms to take a closer look on the distribution at two variables and verify our guess in the last section.

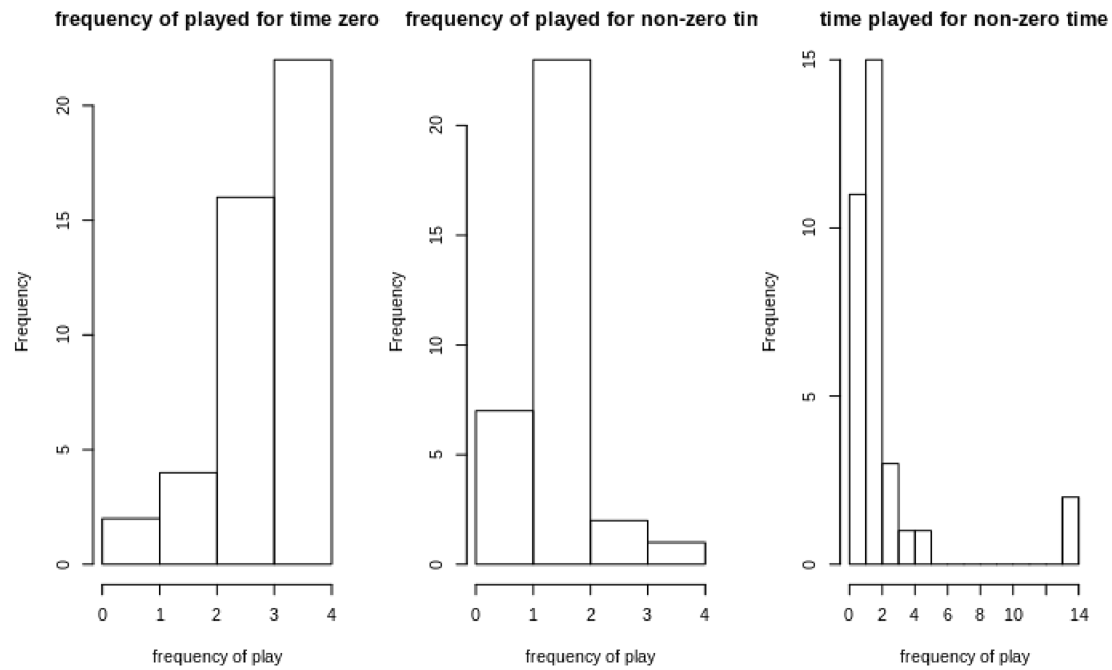


Caption 1: The figures above are the histogram of the frequency of play and time

The histogram for frequency is unimodal with one mode near 2, It's also a little bit left-skewed.

The histogram for the time played is also unimodal, and it has a mode near 0-1. The plot is highly right screwed. A lot of data crowded near 0, and this is probably because 44 out of 77 answered 0 in the survey.

Since most people answered 0 for the time, I believe it's necessary to take a look at the histogram of the frequency for those who answered zero and non-zero values.



Caption 2: The first figure is the histogram for the frequency of play with time played last week to be 0, and the second figure is the histogram for the frequency of play with non-zero time played last week. The last figure is the histogram for time played for a student who has a non-zero time played.

Since 1 indicate playing daily, 2 weekly, 3 monthly, and 4 semesterly, we know a bigger numerical value of the frequency corresponds to a lower frequency. Let's examine the histogram with this idea.

For those who spent zero-hour playing games last week, the lower the frequency of play, the more students fill in that frequency. This makes perfect sense as people who didn't play last week are more likely to be those who didn't play frequently.

Then we focus on the histogram on frequency played for those who played a non-zero time last week. It's now clearly unimodal, with the mode at 2, which is playing weekly. It is a bit right-skewed.

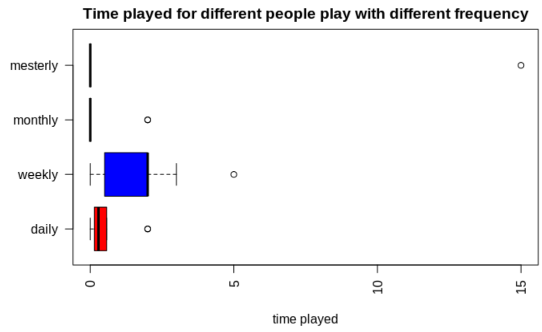
The histogram for time played for non-zero time player is also unimodal, with a clear mode at the bin 1-2 hours.

If we only consider those who played last week, then we believe an average student plays the game at a weekly frequency but a long time around 1-2 hours. If we only try to satisfy those who played last week, we should set a discussion weekly with a duration of 1.5 hours. If we consider all of those who took the survey, the time played is much smaller around 0-1 hour, and the frequency is also very small and peaked around weekly, so we should design the discussion to be weekly with a duration of 30 to 50 minutes.

So far, we have only looked at what's the best duration of the discussion that would fit most people's desires, but we haven't examined the relationship between the time played and the frequency of play. This will be further discussed in the next section.

4.2.3 Method3: Box plot

In this section, we will examine the relationship between duration for each time they play and frequency by using a box plot. Since the variable time only tells us how much time did they spend in a week, we have no idea how long they spend every time they play, so we need to deal with the data first. For the group who play daily, we divide the time data by 7 to calculate the time taken for each time they play; for group weekly, we leave as it was; for group monthly and semesterly, we assume that the time they played will be the only time they play in the week or semester, so we leave the data as before. With this in mind, we plot the following box plot.



Caption 3: The above figure is a box plot regarding different groups of frequency.

From the figure above, we can observe that those who played weekly tend to play for a longer time every time they play, the value for daily has a relatively shorter one. For monthly and semesterly data, their time is approximately zero. Therefore, people who play daily, play with a shorter burst of time, and people who play weekly, play for a longer duration.

Therefore, if possible, we could provide two types of discussion. One only lasts thirty minutes but holds three times a week, the other lasts one and half an hour but only holds once a week. However, we would like to admit that there exists some inaccuracy, since people who consider themselves to play daily may only play for three to four times a week.

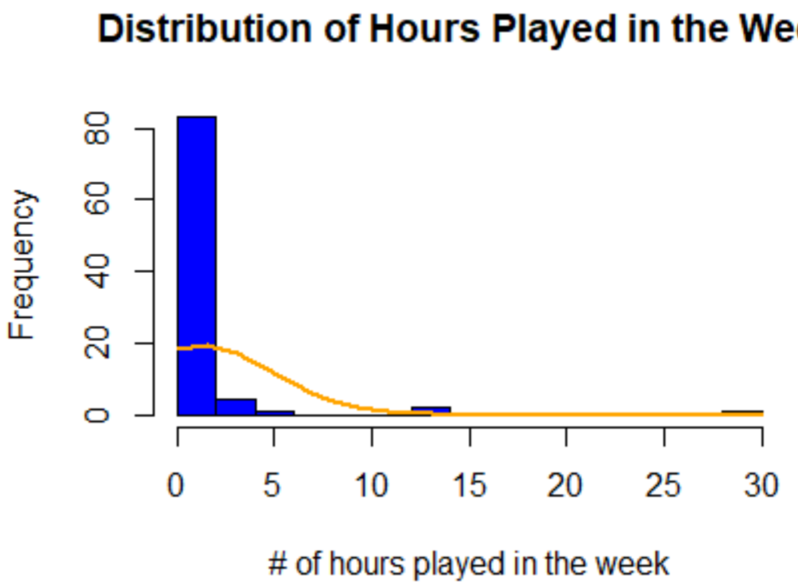
4.2.4 Limitation

There is a significant limitation in this experiment as the variable time is the time played before the week of the exam. The pressure of exam will inevitably influence the time students spent on the game. This may explain why a lot of people fill in time zero though they believe they play daily or weekly as they may consider the game playing to be a less efficient way of review.

4.3 Scenario 3

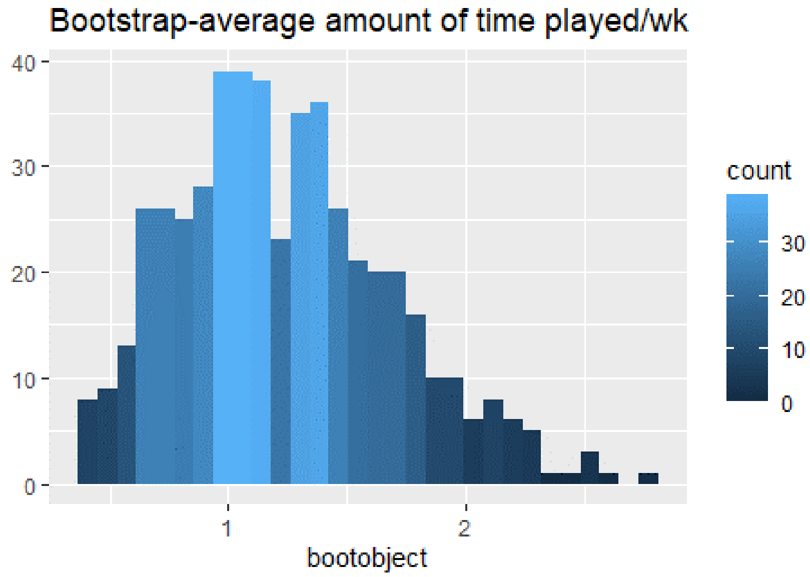
4.3.1 Use the Bootstrap Technique

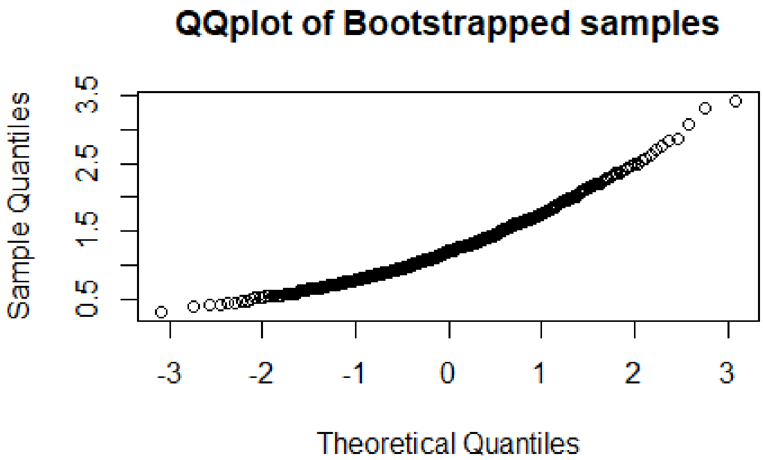
In Scenario 3, we wanted to investigate the interval estimate for the average amount of time spent playing video games in the week prior to the survey. According to the interest of investigation, we first pictured the sample distribution of time variable – number of hours played in the week prior to survey – with the normal curve in the data set.



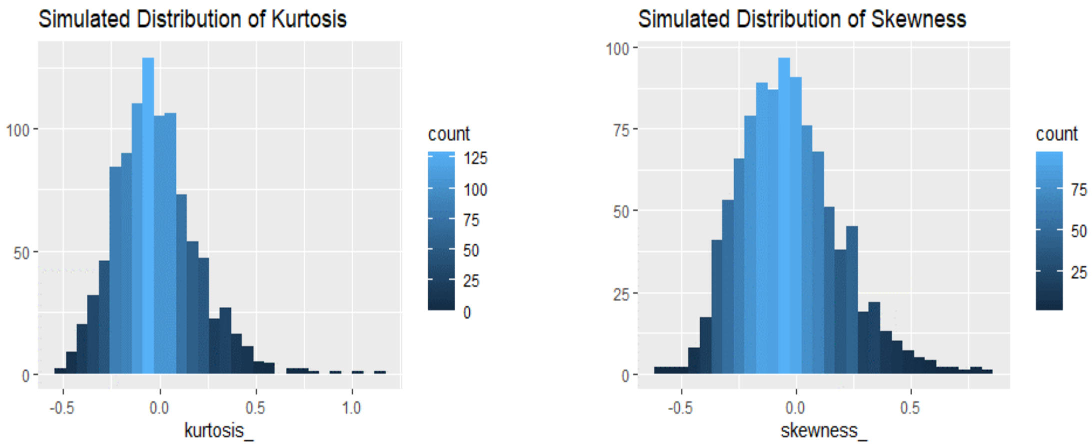
Caption 4: From the figure above, the distribution of the number of the hours played in the week was very skewed to the right, which meant that the majority of people did not play the video games that much comparing to those who played over 25 hours in the week.

The skewness of the sample could not provide enough statistical persuasion. Therefore, bootstrapping was adopted to simulate the data and to qualify the uncertainty of the estimated interval. In order to compute the confidence interval of time average that followed normal curve, we took 500 bootstrap samples from the bootstrap population which here was the samples in the original data.





The bootstrapped sample was a reasonable simulation because the QQ plot indicated that the bootobject was close to normal. Each bootstrapped sample contain 55 samples here. Thus, we did further analysis and checked the normality of the bootstrapped objects by computing the kurtosis 1.000189 and skewness 0.9074091.



Caption 6: Both graphs showed normality; and the average of every kurtosis was -0.11900885, and the average of every skewness was -0.19773595.

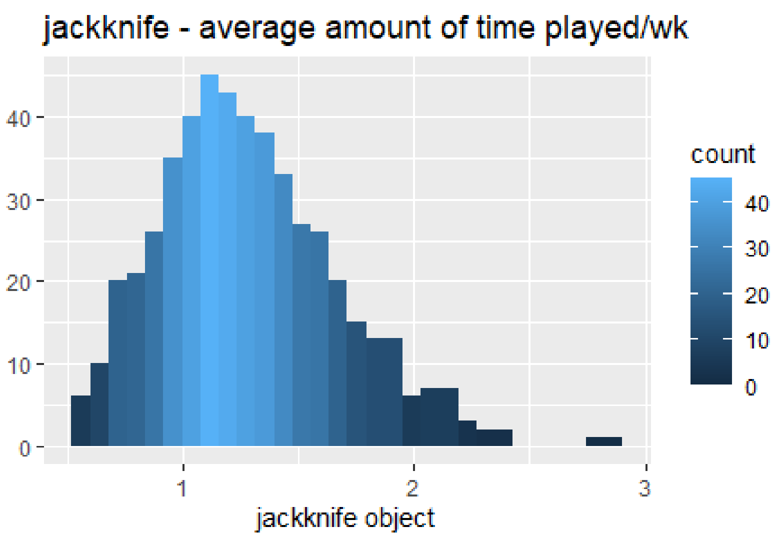
When the average of kurtosis and skewness were close to 0 here, the bootstrapped distribution was normally distributed. Then, we could produce the confidence interval based on the Bootstrapped data.

```
[1] 1.196282 1.275958
attr(,"conf.level")
[1] 0.95
```

As a result, the 95% confidence interval was [1.196282, 1.275958]; 95% of the students in this class played the video games from 1.196282 hours to 1.275958 hours in the week. We could conclude that most student played video games for about one hour a week.

4.3.2 Jackknife Comparison

We conducted another around of experiment using the Jackknife and compared it with the Bootstrap. We took 500 jackknife samples as well. Each jackknife sample contains 90 samples.



Caption 8: Kurtosis was 0.4292271, and the average of every skewness was 0.6191458.

Compared to the kurtosis and skewness in bootstrapped samples, the kurtosis and skewness of the Jackknife samples are more close to 0, which means that jackknife was a better option here. Jackknife performed better than bootstrap in small original data set. The 95% confidence interval for jackknife sampling is [1.250776 1.319073], which also indicates that the average of video game playing time is about 1 hour per week.

4.4 Scenario 4

In this section, we want to examine how probable a student of this kind like to play video games. We first look at the general pattern. In general, we believe students enjoy playing the video games. This is because after cleaning data with sample size of 89 students, it is easy to find 23 students very like playing the video games and 46 students somewhat like playing the video games while only 13 students do not really like playing the video games and only 7 students do not like video games at all. We then work on the following proportional test.

We find that the number of students who very like or somewhat like games are 23 + 46 = 69 out of 90.

```
	1-sample proportions test with continuity correction

data:  69 out of 89, null probability 0.5
X-squared = 25.888, df = 1, p-value = 1.809e-07
alternative hypothesis: true p is greater than 0.5
95 percent confidence interval:
 0.6889504 1.0000000
sample estimates:
        p 
0.7752809 
```

Caption 9: In this test, we find a strong statistical evidence that students are likely to like playing video games. The estimate portion is 0.7752809. Hence, we can conclude that a large portion of the students like or at least somewhat like the video games.

For the response on the reasons behind why those students like or dislike playing video games, 87 students (after data cleaning) give responses who can at most choose three reasons for their attitudes towards playing video games. For the list of why students like playing video games, “relaxation”, “felling of mastery”, “bored”, “graphic/realism”, “mental challenge” will be on the list, ranking from biggest to smallest. This is because the corresponding data for these five reasons are 58, 25, 24, 23, 21 students among 87, which are relatively big. We then perform a proportion test on the most probable candidate ”relaxation”.

```
	1-sample proportions test with continuity correction

data:  58 out of 87, null probability 0.5
X-squared = 9.0115, df = 1, p-value = 0.001341
alternative hypothesis: true p is greater than 0.5
99 percent confidence interval:
 0.5365478 1.0000000
sample estimates:
        p 
0.6666667 
```

Caption 10: In this test, we find a strong statistical evidence that students are likely to like playing video games because of the game’s relaxing features. The estimate portion is 0.6666667. Hence, we can conclude that a large portion of the students like playing video games because of that.

Relaxation is the biggest reason (statistically proved a ”reason”) while the latter four reasons seem to have similar influence on students’ attitudes. The only reason excluded from the list is “eye/hand coordination”, as only 8 responses include this reason which is relatively small compared to other reasons.

Meanwhile, for the list of reasons why students dislike playing video games, the reasons “too much time”, “costs too much”, “it is pointless”, “frustrating”, “too many rules”, “boring” will be included on the list with corresponding data 42, 35, 29, 23, 17, and 14 responses from the sample of 87 students. These data reflect students regard these 6 points as main reasons why they hold negative attitudes towards playing video games. The reasons which would be excludes from the list based on the cleaned data is “lonely”, and “friends don’t play” because only 8 and 6 responses mention these two reasons which are in low frequency compared to the 6 reasons in the list.

Based on the findings, we conclude that games are usually attractive to students. Then it is possible to design games for educational purpose in the computer labs. However, we should narrow down the target groups to make a closer examination to this conclusion. This is shown in scenario 5. On the other hand, if it is applicable to design such games, we may consider making use of the reasons like/dislike video games shown above. That is, we should consider making relaxing, mastering, interesting, graphical real, and challenging games and avoiding features like pointless, too hard, too many rules, etcetera. Notice that we only statistically prove "relaxing" is a reliable feature, while other factors are likely to be influencing but still require further studies.

4.5 Scenario 5

In this section, we test whether gender information, computer ownership, and playing purpose (educational/non-educational) would affect students' preference of video games. We first observe that there are five levels for the "like" variable, where one level is "never played". Hence, we eliminate this level to better assess preference based on responses from those who have played video games before. Since there are only 89 observations left, we collapse the remaining four levels into two, where the "Like" category contains "very much" and "somewhat" and the "Dislike" category contains "not really" and "not at all" in order to make the statistical process more convincing. Then we can see the graph below.

	gender	
attitude	f	M
Like	26	42
Dislike	12	8

	own	
attitude	NO	YES
Like	21	47
Dislike	3	17

	educ	
attitude	NO	YES
Like	30	35
Dislike	10	2

Caption 11: In these three graphs, we can clearly see in each that the "like" section has a much higher frequency than the "dislike" section. For female, the proportion to enjoy playing games is 26/38 = 0.684. For male the proportion is 42/50 = 0.84. For those possess a computer the proportion is 47/64 = 0.734 while those who don't have one is 21/24 = 0.875. For those who play for educational purpose is 35/37 = 0.946. For those for don't for educational purpose the proportion is 30/40 = 0.75.

We can see in each category that the proportion is well over 50%. For male, those don't own a computer, and those play games for educational purpose, the "like video games" rate is over 80 percent. That implies an overall preference of video games regardless of categorizing the data between female and male, computer ownership, or game-playing purpose in this specific student population. This finding proves that students studied indeed have an overall preference of video games so that we should put specific attention on that when we design the new labs. Furthermore, we can perform the proportion test to test independence of each pair of two categories of variables in order to narrow down our research direction.

```
        2-sample test for equality of proportions with continuity correction

data:  c(26, 42) out of c(38, 50)
X-squared = 2.1627, df = 1, p-value = 0.1414
alternative hypothesis: two.sided
95 percent confidence interval:
 -0.35830239  0.04672344
sample estimates:
   prop 1    prop 2 
0.6842105 0.8400000 

        2-sample test for equality of proportions with continuity correction

data:  c(21, 47) out of c(24, 64)
X-squared = 1.2463, df = 1, p-value = 0.2643
alternative hypothesis: two.sided
95 percent confidence interval:
 -0.05894537  0.34019537
sample estimates:
  prop 1   prop 2 
0.875000 0.734375 

        2-sample test for equality of proportions with continuity correction

data:  c(30, 35) out of c(40, 37)
X-squared = 4.219, df = 1, p-value = 0.03997
alternative hypothesis: two.sided
95 percent confidence interval:
 -0.37465376 -0.01723813
sample estimates:
   prop 1    prop 2 
0.7500000 0.9459459 
```

Caption 12: The p-values are 0.1414, 0.2643, and 0.03997, respectively. Reading these results, we observe that there is no strong statistical evidence suggesting that there is a preference difference between female and male, and whether the student owns a computer. However, there is a strong statistical evidence showing that those students who play games for educational purpose has a higher possibility to like video games comparing to those who play for non-educational purpose.

From the tests, we observe that those playing for educational purpose are more likely to like playing video games. Due to its educational purpose, this finding implies that the new labs can involve well-designed educational video games aiming to better teach students. It is left to show that we can guide students to play games for educational purpose. Once they do, the lab leaders can guide them so and that they are very likely to like this game based on our finding. With this subjective, positive preference, we can probably better achieve the labs' educational goals.

4.6 Scenario 6

In Scenario 6. we want to further investigate the connection between the grade that students expect and their video games preference. Moreover, the overall grade expectation is calculated and compared with the target distribution of 20% A's, 30% B's, 40% C's and 10% D's and lower. Lastly, we assume the nonrespondents were failing students who no longer bothered to come to the discussion section and see if the assumption will influence the outcome in the previous step.

4.6.1 Connection Between Students' Grade Expectations and Their likeness of Video Games

In this section, we examine the connection between the grade that students expect and their likeness of video games. As one students didn't state his game likeness, we remit him from the data and use the data of remaining 90 students for analysis.

For the one students who never played action games, he expect to receive A on this course.

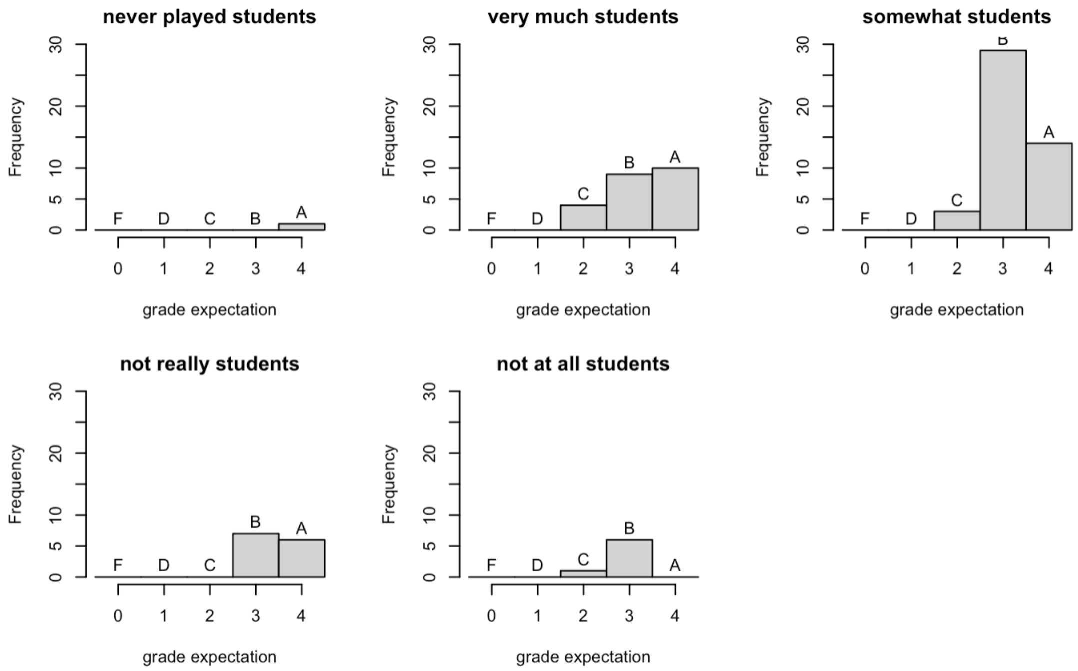
For the 23 students who liked playing games very much, the average grade expectations of them are 3.26087 with the standard error 0.7518094. The skewness is -0.4527882 which is left-skewed, and the kurtosis is 1.953959 which is platykurtic.

For the 46 students who somewhat liked playing games, the average grade expectations of them are 3.23913 with the standard error 0.5650873. The skewness is 0.00776733 which is right-skewed, and the kurtosis is 2.642073 which is platykurtic.

For the 13 students who do not really like playing games, the average grade expectations of them are 3.461538 with the standard error 0.5188745. The skewness is 0.1543033 which is right-skewed, and the kurtosis is 1.02381 which is platykurtic.

For the 7 students who don't like playing games, the average grade expectations of them are 2.857143 with the standard error 0.3779645. The skewness is -2.041241 which is left-skewed, and the kurtosis is 5.166667 which is not platykurtic.

Overall, most of these distributions are left-skewed, except students who somewhat like playing games and students who don't really like playing games, and all the kurtosis are platykurtic except students who don't like playing games. The students who didn't really like playing games have the highest grade expectations, while the students who didn't like playing games have the lowest grade expectations. The histograms below visualize the above statistics of students' grade expectation for each type of game.



Caption 13: The figures are the distributions of students' expectation grades for whether they like playing games

Interestingly, from the histogram we can see that students who like playing video games very much and somewhat have higher expectations on their grade. But overall, students who somewhat like playing video games have the highest expectation on their grade. Also, the students who never played the games expect to receive A. In contrast, the students who have played video game before but didn't like it have the lowest grade expectations.

4.6.2 Connection Between Students' Grade Expectations and Their Video Games Preference on Types of Games

In this section, we examine the connection between the grade that students expect and their video games preference on types of games. As 4 students didn't state their game preference, we remit them from the data and use the data of remaining 87 students for analysis.

For the 45 students who played action games, the average grade expectations of them are 3.266667 with the standard error 0.653661. The skewness is -0.3203989 which is left-skewed, and the kurtosis is 2.279538 which is platykurtic.

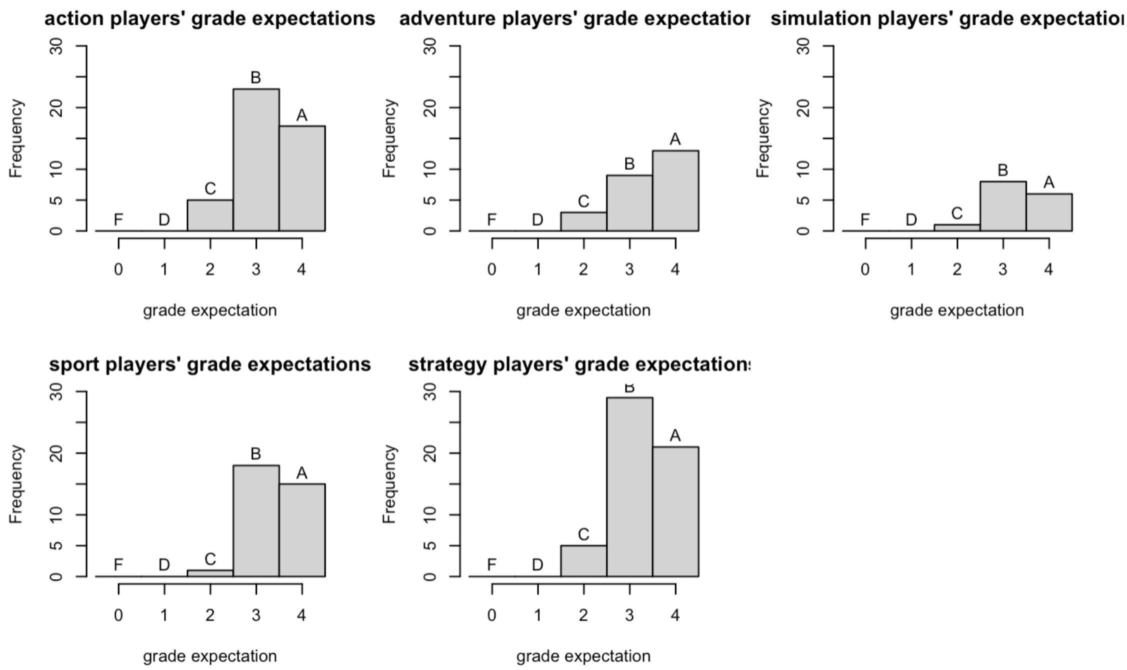
For the 25 students who played adventure games, the average grade expectations of them are 3.4 with the standard error 0.7071068. The skewness is -0.7216878 which is left-skewed, and the kurtosis is 2.333333 which is also platykurtic.

For the 15 students who played simulation games, the average grade expectations of them are 3.333333 with the standard error 0.6172134. The skewness is -0.2795085 which is left-skewed, and the kurtosis is 2.34375 which is also platykurtic.

For the 34 students who played sport games, the average grade expectations of them are 3.411765 with the standard error 0.5569205. The skewness is -0.18115 which is left-skewed, and the kurtosis is 2.040032 which is also platykurtic.

For the 55 students who played strategy games, the average grade expectations of them are 3.290909 with the standard error 0.6287179. The skewness is -0.299511 which is left-skewed, and the kurtosis is 2.342072 which is also platykurtic.

Overall, all of these distributions are left-skewd and platykurtic. The sports players have the highest grade expectations, while the strategy players have the lowest grade expectations. The histograms below visualize the above statistics of students' grade expectation for each type of game.



Caption 14: The figures are the distributions of students' expectation grades for each type of the games

According to the histograms above, most action, simulation, sport, and strategy players expect to receive B on this course. However, most adventure players expect to receive A. None of students in this class expect to receive D or lower, and few of them expect receive C. So in conclusion, most students expect to receive B and above, and adventure players have higher expectation on their grades than other games players.

4.6.3 Overall Grade Expectations versus Target Distribution

For the 91 investigations we have, 31 students expect to receive A, which is 34.07% of the population we have; 52 students expect to receive B, which is 57.14% of the population; only 8 students expect to receive C, which is 8.79% of the population, and none of students expect to receive D or lower. Since our target distribution is 20% A's, 30% B's, 40% C's and 10% D's and lower, the students' expectations are much higher than the target.

To further investigate the difference, we apply the hypothesis testing for proportions. For students who expect to receive A, the null hypothesis is H0: p = 0.2, and the alternative hypothesis is H1: p >0.2.

```
            1-sample proportions test without continuity correction

data:  A out of 91, null probability 0.2
X-squared = 11.253, df = 1, p-value = 0.0003975
alternative hypothesis: true p is greater than 0.2
95 percent confidence interval:
 0.2645983 1.0000000
sample estimates:
        p
0.3406593
```

Caption 15: The outcome of hypothesis testing for proportion on students who expect to receive A

Since the p value is pretty small, at a given significance level alpha = 0.05, we reject the null hypothesis and conclude that there is strong statistical evidence that the proportion that students expect to receive A is more than 20%.

Similarly, we do the hypothesis testing for proportion on students who expect to receive B, C, and D or lower. The hypothesis for B is H0: p = 0.3, H1: p 0.3. The p-value we get is 8.011e-09, which is still pretty small. So with the significance level at 0.05, we reject the null hypothesis and conclude that there is strong statistical evidence that the proportion that students expect to receive B is more than 30%.

Since the students who expect to receive C is fewer than we target, the hypothesis for students who expect to receive C is H0: p = 0.4, H1, p 0.4. The p-value we get is 6.121e-10, which is smaller than 0.05, so students expect to receive B is fewer than 40%. For the students who receive D or lower, the hypothesis is H0: p = 0.1, H1, p 0.1. The p-value is 0.3504. Since the p-value is larger than 0.05, we fail to reject the null hypothesis.

However, if we count the 4 nonrespondents as the students who fail the courses, the picture might have some changes. The number of students who expect A, B, and C are similar, but the proportion change to 32.63%, 54.74%, 8.42% respectively. The number of students who receive D or lower is 4, and the proportion is 4.21%.

Then we apply the hypothesis testing for proportion again. With the same hypothesis, the p-values for students who expect to receive A, B, C, and D or lower are 0.001042, 7.15e-08, 1.663e-10, 0.304 respectively. The conclusion are also the same, so we can conclude that if we assume the non-respondents were those who would fail the class, the outcomes weren't influence a lot.

4.7 Additional Questions

Adding to the above investigations, we want to further investigate what are some candidate variables influencing students' grade expectation in the computer labs.We used linear regression to construct the relationship.

```
Call:
lm(formula = grade ~ ., data = games6)

Residuals:
     Min       1Q   Median       3Q      Max 
-1.17238 -0.41271  0.00026  0.40255  0.95252 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept)  2.989845   0.724812   4.125 9.39e-05 ***
time        -0.011194   0.019958  -0.561 0.576527    
like        -0.004900   0.006252  -0.784 0.435564    
where       -0.001744   0.003385  -0.515 0.607969    
freq         0.008380   0.004526   1.851 0.068012 .  
busy        -0.004697   0.004124  -1.139 0.258351    
educ        -0.002846   0.003489  -0.816 0.417259    
sex          0.449029   0.126775   3.542 0.000683 ***
age         -0.009155   0.034438  -0.266 0.791089    
home         0.407674   0.150696   2.705 0.008421 ** 
math        -0.011035   0.007900  -1.397 0.166555    
work        -0.003602   0.003683  -0.978 0.331218    
own         -0.218719   0.152909  -1.430 0.156706    
cdrom       -0.002560   0.002863  -0.894 0.374091    
email        0.166755   0.154929   1.076 0.285185    
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5567 on 76 degrees of freedom
Multiple R-squared:  0.2903,	Adjusted R-squared:  0.1596 
F-statistic:  2.22 on 14 and 76 DF,  p-value: 0.01412
```

Caption 16: The outcome of hypothesis testing for proportion on students who expect to receive A

From this test, we observe that it is statistically significant that "sex" and "home" are two of the impacting variables that change students' grade expectation. Specifically, that is to say male and female students have a significant grade difference in the lab while those who possess a computer at home have a significant grade expectation difference from those who do not have one. Since we have investigated in scenario 4 that male students have a higher "like game" possibility and sex is a variable taken as given by each individual, this finding paves the way to a further study that sex may affect game preference and grade expectation in computer labs, while each of these two explanatory variables can be confounders for each other. However, it is worth noticing that the sex difference in "game-playing" is proved not statistically significant in our study despite the big difference in mean. This is possibly caused by a small sample size or specific sample collected. This is one point we should include in further study. Meanwhile, computer ownership at home emerges as a possible impact statistically. This may be explained by a causal effect relationship that since students have computer at home, they have easy assess to it and thus have more time practice or play around with it. This also requires further study. In this additional question, we construct the two lines of statistical relationships. Based on their impact to grade expectation, we may design different study plan or study aid for different group of students in the lab. For example, we should provide easy assess to computer for students and investigate how different sex contributes to different grade. Last but not least, we shouldn't forget to mention that grade expectation reflects an "expectation" and it therefore not the final, true result. Keep in mind with the difference.

5 Conclusion

By looking into the number of students who played video games prior to the survey in our sample, we divide the student population into two groups: played or not played. We find that students who did not play took a slightly larger part of the population. By looking into the gaming frequency of these two groups, we find that the students who played tend to favor longer duration of playing than the average number of the entire sample including all students who took the survey. We also find that students who play weekly favors significantly longer duration in comparison to those who play monthly and daily. This means that in order to design new discussion labs, we might have to design two types of discussions with different duration to meet the demand of the divided student population.

We estimate the average time of gaming in the week prior to the exam by both bootstrap and jackknife re-sampling. We found that most students play video games for about 1 hour per week. This means that one hour would be an ideal duration of our new discussion sections in order to satisfy most students if we only have one type of discussion lab eventually.

Considering gender information and computer ownership, we find that these factors don't significantly affect if a student like to play video games or not. Furthermore, by comparing students who play with educational and non-educational purposes, we find that people who play for educational purposes tend to favor game playing more than those who don't. We conclude that the new lab sections could be game-based at some level to attract more students to participate in discussion, and the new lab sections shouldn't divide students based on gender information and computer ownership.

By hypothesis testing the sample proportions of students who somewhat like playing video games, we conclude that students in general. This make our research practical since the sample we study is representative to the student population, and we are able to generate useful information for designing new discussion labs.

Moreover, the main reason why students like video games is "relaxation". We can create an relaxing atmosphere in our lab sections to attract more students. We also find that students dislike gaming mainly due to the time and cost. It means that students tend to be busy and are sensitive to financial concerns. For this reason, our new discussion sections should be placed at a convenient spot on campus so that students won't spend additional time and money in order to attend discussion sections.

By looking into the histogram graphs of grade expectations of students favoring different types of games and hypothesis testing, we compare the grade expectation of students to our target distribution, which is 20% A's, 30% B's, 40% C's and 10% D's and lower. We find that student expectations are much higher than the target distribution of the group. To mitigate the gap between grade expectation and target distribution, we should include explicit grading standards in our discussion sections.

New discussion lab designed based on the conclusions we generate in this research still might not meet the demand of all students due to the unrepresentativeness of our sample data to the student population. Nonetheless, we still can detect students preferences in some features and design the lab sections that suit the great portion of students.

6 Theory

6.1 Hypothesis Testing for Proportion

Goal of Hypothesis Testing is to determine whether the data provide enough evidence to conclude that some "null hypothesis" about a parameter is false and some "alternative hypothesis" is true.

H0 : there will be no observed effect for an experiment

H1: there will be an observed effect for the experiment

It's test statistics for population proportion are defined as the following:

$$z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}} \tag{1}$$

Then the p-value is calculated by the test statistics above, which is the probability, if H0 is true, of getting a value for the test statistic that is at least as extreme (in the direction of the alternative hypothesis, i.e., favorable to H1) as what was actually observed.

6.2 Central Limit Therom

The Central Limit Theorem states that the sampling distribution of the sample means approaches a normal distribution as the sample size gets larger – no matter what the shape of the population distribution is.

6.3 Bootstrap Confidence Interval

Bootstrap was first described by Bradley Efron. It creates multiple resamples with replacement, from a single set of observations, and computes the effect size of the interest on each of these resamples. The bootstrap resamples of the effect size can then be used to determine the 95% confidence interval. It is common to encounter a skewed distribution, and bootstrap resampling allows the investigator to continue their research based on a much normal graph to obtain statistical validation for estimates. The resampling distribution can approach to normal is due to the Central Limit Theorem.

Bootstrap resampling gives two important benefits:

1. Non-parametric statistical analysis
2. Easy construction of the 95% confidence interval from the resampled distribution

6.4 Standard Error

The estimator for standard error are difined as the following:

$$\hat{SE}(\bar{x}) = \frac{\sqrt{\bar{x}(1-\bar{x})}}{\sqrt{n-1}} \frac{\sqrt{N-n}}{\sqrt{N}} \tag{2}$$

6.5 Multivariate Linear Regression

Multivariate linear regression is used to estimate the association between multiple explanatory variables and a response variable. The model comes in the following format:

$$y = \beta_0 + \beta_1 x_1 + ... + \beta_p x_p \tag{3}$$

Several important assumptions are made regarding to this model:

- The response variable is linearly dependent on all of covariates $x_1, ..., x_p$.
- All of the observations $y_1, ..., y_n$ are independent.
- x_j is uncorrelated to the error ϵ.
- The errorϵ is normally distributed.
- The covariates $x_1, ..., x_p$ are not highly correlated.
- The mean and variance of ϵ_i are the same for i.

6.6 Jackknife Resampling

Jackknife resampling is a technique used to estimate the parameter. It systematically takes out an observation, and average the remaining, and get an estimate. Then, aggregate the estimate for each sub-sample, we are able estimate the parameter.

7 Appendix

7.1 Contribution

- Shuyang Zhang: Did Scenario 3(Coding and Writing parts); wrote data section and part of the theory
- Zetong Lai: Did Scenario 4 and Introduction
- Yibei Cai: Did Scenario 2 and additional question. Review the code as well.
- Yuan Lin: Did Scenario 1 and Conclusion, Theory of standard error.
- Junqian Liu: Did Scenario 6, theory of hypothesis testing for proportion. Review the report as well.
- Yiteng Lu: Did Scenario 5, background, and additional question.

7.2 Citation

1. Professor Danna Zhang's powerpoint from MATH 181A.
2. Professor Wenxin Zhou's power point from MATH 185.
3. Joses Ho, Bootstrap Confidence Interval, *Using the bootstrap to construct confidence Interval* 2019. `https://acclab.github.io/bootstrap-confidence-intervals.html`
4. Central Limit Theorem, Statistics How to, `https://www.statisticshowto.com/probability-and-statistics/normal-distributions/central-limit-theorem-definition-examples/`
5. Thomas Hainey, Wim Westera, Thomas M. Connolly, Liz Boyle, Gavin Baxter, Richard B. Beeby, Mario Soflano, Students' attitudes toward playing games and using games in education: Comparing Scotland and the Netherlands, Computers Education, Volume 69, 2013, Pages 474-484, ISSN 0360-1315, `https://doi.org/10.1016/j.compedu.2013.07.023`.
6. Brittany Steiner, Nancy Kaplan, and Stuart Moulthrop. 2006. When play works: turning game-playing into learning. In Proceedings of the 2006 conference on Interaction design and children (IDC '06). Association for Computing Machinery, New York, NY, USA, 137–140. DOI: `https://doi.org/10.1145/1139073.1139107`
7. "Jackknife Resampling." Wikipedia, Wikimedia Foundation, 21 Dec. 2020, `en.wikipedia.org/wiki/Jackknife_resampling`.