MATH 140 **Name** _____ **Date:**

Worksheet: ESP Testing (based on an activity in *Workshop Statistics*, by Rossman & Chance.)

The Scene: A common test for extra-sensory perception (ESP) asks a subject to identify which of four shapes (star, circle, wave, or square) appears on a card unseen by the subject. In this activity we test everyone in this class for ESP! Get into groups of 3. Each group will get 4 cards (one from each suit). Each student in the group gets to be tested.

The Procedure: The "experimenter" holds up one card and the "subject" guesses which suit appears on the card (heart, club, diamond, or spade). Repeat 28 times, and record the number of correct identifications.

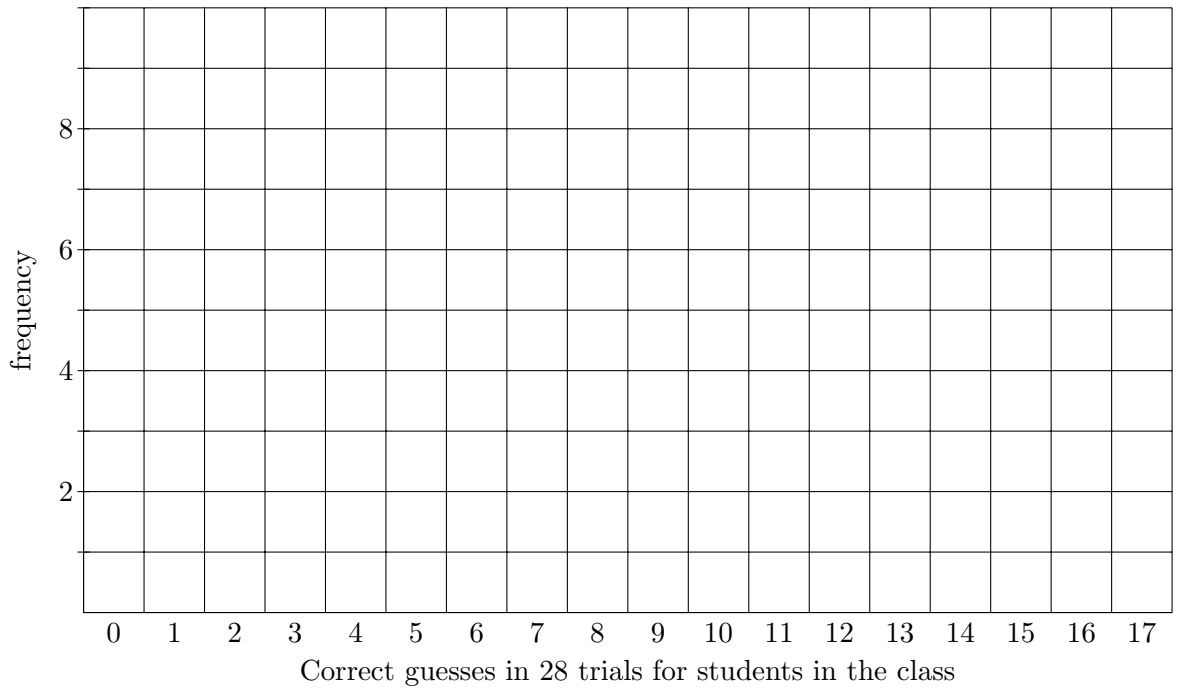
1. Complete the procedure for each student in your group and record the results below. Ideally, each student in the group will also get to be the "experimenter" once.

subject	experimenter	correct identifications in 28 trials

2. If a subject is truly guessing, what proportion would the subject get correct in the long run? In other words, what is the probability of a correct identification for a "guesser"?

   We might consider a student to have ESP if he or she would get more than 25% correct in the long run.

3. We will now pool the class data on the chalkboard. Create a barplot below to summarize the pooled data.



4. How many students in the class did better than 25%? What proportion of the class is this?

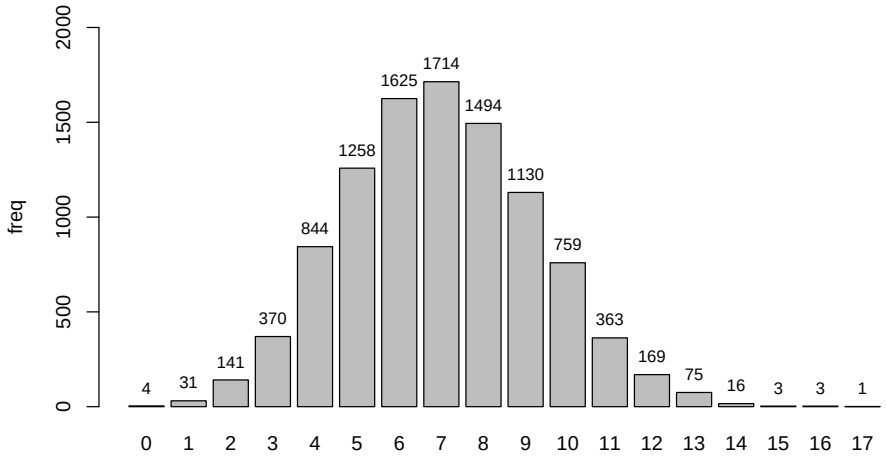
5. Do you believe that a student who did better than 25% correct in these 28 trials has ESP? Explain.

6. Do you believe that a student who did better than 50% correct in these 28 trials has ESP? Explain.

To better answer these questions, we quickly simulate 10,000 repetitions of this procedure in R with the following code. The data set `simcounts` stores the outcome of these 10,000 repetitions. That is, `simcounts` has 10,000 values, and `simcounts[i]` gives the number of correct identifications (out of 28 guesses) on the ith repetition of the procedure.

```
cards=c("d","h","s","c")
simcounts = c()
trials=10000
for (i in 1:trials){
  numcorrect=0
  for (g in 1:28){
    card=sample(cards,1)
    guess=sample(cards,1)
    numcorrect=numcorrect+sum(card==guess)}
  simcounts =c(simcounts,numcorrect)}
# Making a barplot with values above bars
x<- barplot(table(simcounts),ylab="freq",ylim =c(0,2000))
y<-table(simcounts)
text(x,y+2,labels=as.character(y),pos = 3,cex=.8)
```

So we have 10,000 students in this simulation going through the procedure, and the results of the simulation are presented in the bar graph below.



7. Based on this simulation, what is a reasonable estimate for the probability that a person would get 8 or more correct guesses in 28 attempts? Note: In R the code `sum(simcounts>=8)` will find the number of values in `simcounts` that are 8 or larger.

8. Based on this simulation, how surprising would it be for a subject to get 12 or more correct guesses in 28 attempts? Include a probability estimate in your answer.

9. Suppose that a particular subject gets 17 correct in a test. How convinced would you be that she actually possesses the ability to get more than 25% correct in the long run? Explain, basing your argument on the results of the simulated tests.