Using the Binomial Distribution on the TI–84+

The Binomial Distribution is a <u>discrete</u> probability distribution that summarizes the likelihood that a value will take one of two independent values under a given set of parameters or assumptions. The underlying assumptions of the Binomial Distribution are that there is only one outcome for each trial, that each trial has the same probability of success and that each trial is independent from the next.

Each Binomial Distribution uniquely corresponds to the number of trials n and the probability of success p, where:

$$\mu = np \quad \text{and} \quad \sigma = \sqrt{npq}\,.$$

The Binomial Distribution on the TI–84+ exists in two forms:

- Probability Density Function: **binompdf(**
- Cumulative Distribution Function: **binomcdf(**

Both the **PDF** and **CDF** functions require the same initial information in order to calculate the probability. You will need to specify the number of trials n, the probability of a success p, and the x–value.

Binomial PDF
Used to calculate EXACTLY x. Think $P(X = x)$.
Function name: **binompdf(**

Binomial CDF
Used to calculate AT MOST x. Think $P(X \le x)$.
Function name: **binomcdf(**

Note: The difference between the PDF function and CDF function is that the CDF is a cumulative sum that calculates all probabilities less than or equal to the value of x.

Consider n trials, with the probability of a success p. The difference between: binom***<u>pdf</u>***(n, p, 3) and binom***<u>cdf</u>***(n, p, 3).

- ✓ binom***<u>pdf</u>***(n, p, 3) → $P(X = 3)$ represents the probability that **<u>EXACTLY</u>** 3 successes will occur in n trials, with the probability of each success p.
- ✓ binom***<u>cdf</u>***(n, p, 3) → $P(X \le 3) = P(X = 0) + P(X = 1) + P(X = 2) + P(X = 3)$ represents the probability that **<u>AT MOST</u>** 3 successes will occur in n trials, with the probability of each success p.

The TI 84+ can only calculate $P(X = x)$ and $P(X \le x)$, yet, there are a few other situations that we encounter. Here is the summary of syntax for those situations:

** SUMMARY OF SYNTAX **	
<u>SITUATION</u>	**<u>SYNTAX</u>**
1) $P(X = x)$	**binompdf(** n, p, x)
2) $P(X \le x)$	**binomcdf(** n, p, x)
3) $P(X \ge x)$	1 – **binomcdf(** $n, p, x - 1$)
4) $P(a \le X \le b)$	**binomcdf(** n, p, b) – **binomcdf(** $n, p, a - 1$)

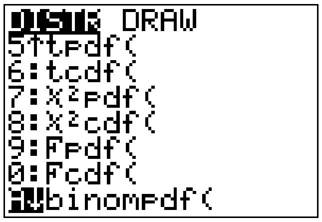
<u>Example:</u> 79% percent of the students of a large class passed the final exam. A random sample of 6 students are selected to be analyzed by the school. What is the probability that the number of students that passed the exam is

a) exactly 3 **b)** at most 2 **c)** 4 or greater **d)** between 3 and 5 inclusive

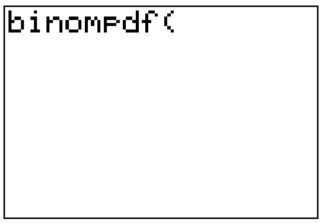
Solution 1a	We want the probability that the number of students that passed the exam is exactly 3. Thus, we want $P(X = 3)$, which is a simple pdf (probability density function) on the TI-84+.

TI-83+, TI-84+ (2.53MP and earlier)

Key in: 2nd DISTR select **binompdf(** ENTER



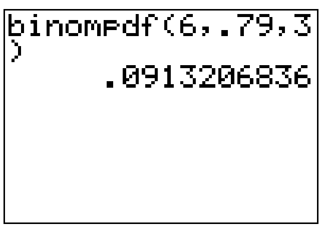
This should be the screen you see.



The syntax for: **binompdf(** is

binompdf(***n*** **,** ***p*** **,** ***x*** **)**

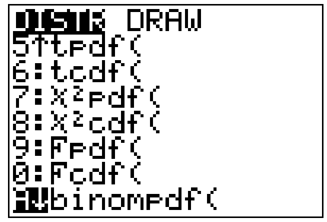
Key in: **6** , **.79** , **3**) ENTER



Thus, the probability that the number of students that that passed the exam is exactly 3 is approximately 0.0913.

TI-84+ (2.55MP)

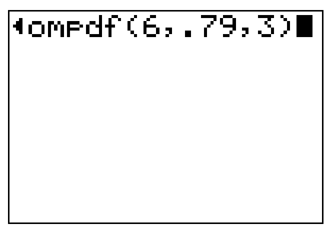
Key in: 2nd DISTR select **binompdf(** ENTER



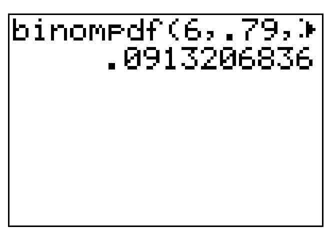
This should be the screen you see.

Key in: **6** ENTER **.79** ENTER **3** ENTER

Your cursor is on Paste, so, press ENTER again.



Press ENTER one more time.

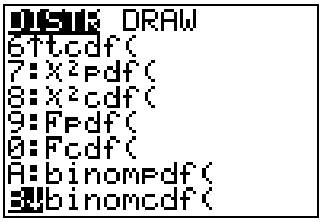


Thus, the probability that the number of students that that passed the exam is exactly 3 is approximately 0.0913.

Solution 1b We want the probability that the number of students that passed the exam is at most 2. Thus, we want $P(X \le 2)$, which is a simple cdf (cumulative distribution function) on the TI-84+.

TI-83+, TI-84+ (2.53MP and earlier)

Key in: [2nd] [DISTR] select **binomcdf(** [ENTER]

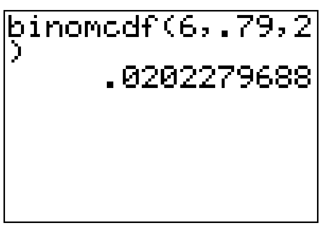


This should be the screen you see.

The syntax for: **binomcdf(** is

binomcdf(***n*** **,** ***p*** **,** ***x*** **)**

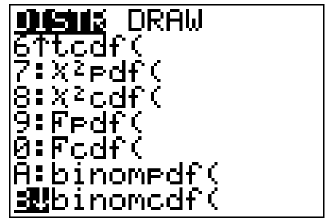
Key in: **6** [,] **.79** [,] **2** [)] [ENTER]



Thus, the probability that the number of students that that passed the exam is at most 2 is approximately 0.0202.

TI-84+ (2.55MP)

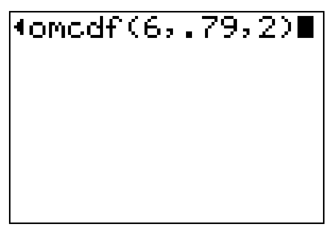
Key in: [2nd] [DISTR] select **binomcdf(** [ENTER]



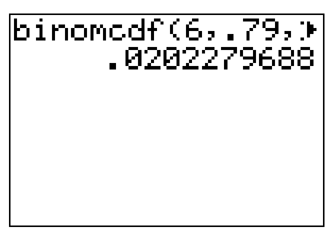
This should be the screen you see.

Key in: **6** [ENTER] **.79** [ENTER] **2** [ENTER]

Your cursor is on Paste, so, press [ENTER] again.



Press [ENTER] one more time.



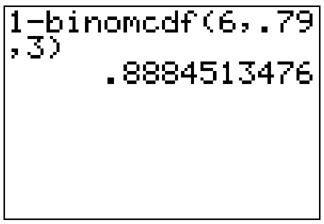
Thus, the probability that the number of students that that passed the exam is at most 2 is approximately 0.0202.

Solution 1c

We want the probability that the number of students that passed the exam is 4 or greater. Thus, we want $P(X \geq 4)$. Since the calculator calculates up to at most a particular value and not greater or greater than or equal to, then we need to rewrite our inequality of strictly ≤ signs, so that we can answer the question correctly. So, $P(X \geq 4) = 1 - P(X < 4)$. Since we are dealing with a Binomial distribution, then we know we are taking on discrete values. Thus, $P(X \geq 4) = 1 - P(X < 4) = 1 - P(X \leq 3)$. {That's because $P(X < 4) = P(X \leq 3)$}. Now, we just need to calculate $1 - P(X \leq 3)$ on the TI-84+.

TI-83+, TI-84+ (2.53MP and earlier)

- Key in: **1** then [–]
- Key in: [2nd] [DISTR] select **binomcdf(** [ENTER]
- Key in: **6** [,] **.79** [,] **3** [)] [ENTER]



Thus, the probability that the number of students that that passed the exam is 4 or greater is approximately 0.8885.

TI-84+ (2.55MP)

- Key in: **1** then [–]
- Key in: [2nd] [DISTR] select **binomcdf(** [ENTER]
- Key in: **6** [ENTER] **.79** [ENTER] **3** [ENTER × 2]

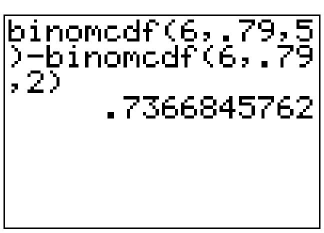
Thus, the probability that the number of students that that passed the exam is 4 or greater is approximately 0.8885.

Solution 1d

We want the probability that the number of students that passed the exam is between 3 and 5 inclusive. Thus, we want $P(3 \leq X \leq 5)$, which is equivalent to the statement $P(X \leq 5) - P(X < 3)$ which is equivalent to $P(X \leq 5) - P(X \leq 2)$. So, we need to find the difference of two simple cdfs on the TI-84+.

TI-83+, TI-84+ (2.53MP and earlier)

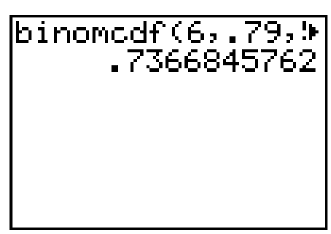
- Key in: [2nd] [DISTR] select **binomcdf(** [ENTER]
- Key in: **6** [,] **.79** [,] **5** [)]
- Key in: [–] (Note: minus sign, not negative sign)
- Key in: [2nd] [DISTR] select **binomcdf(** [ENTER]
- Key in: **6** [,] **.79** [,] **2** [)] [ENTER]



Thus, the probability that the number of students that that passed the exam is between 3 and 5 inclusive is approximately 0.7367.

TI-84+ (2.55MP)

- Key in: [2nd] [DISTR] select **binomcdf(** [ENTER]
- Key in: **6** [ENTER] **.79** [ENTER] **5** [ENTER × 3]
- Key in: [–] (Note: minus sign, not negative sign)
- Key in: [2nd] [DISTR] select **binomcdf(** [ENTER]
- Key in: **6** [ENTER] **.79** [ENTER] **2** [ENTER × 3]



Thus, the probability that the number of students that that passed the exam is between 3 and 5 inclusive is approximately 0.7367.

Sample TI Calculator Quiz on Binomial Distribution

Example:

Find each of the following using a TI-calculator. Round all answers to three decimal places.
A basket contains 70 good apples and 30 bad apples. Eight apples are drawn at random from this basket.
Find the probability that of the eight:

a) exactly two are good apples **a)** ______________________

b) at most three are good **b)** ______________________

c) at least five are good **c)** ______________________

d) between 4 and 6 inclusive are good. **d)** ______________________

Solution:
a) .010 **b)** .058 **c)** .806 **d)** .687