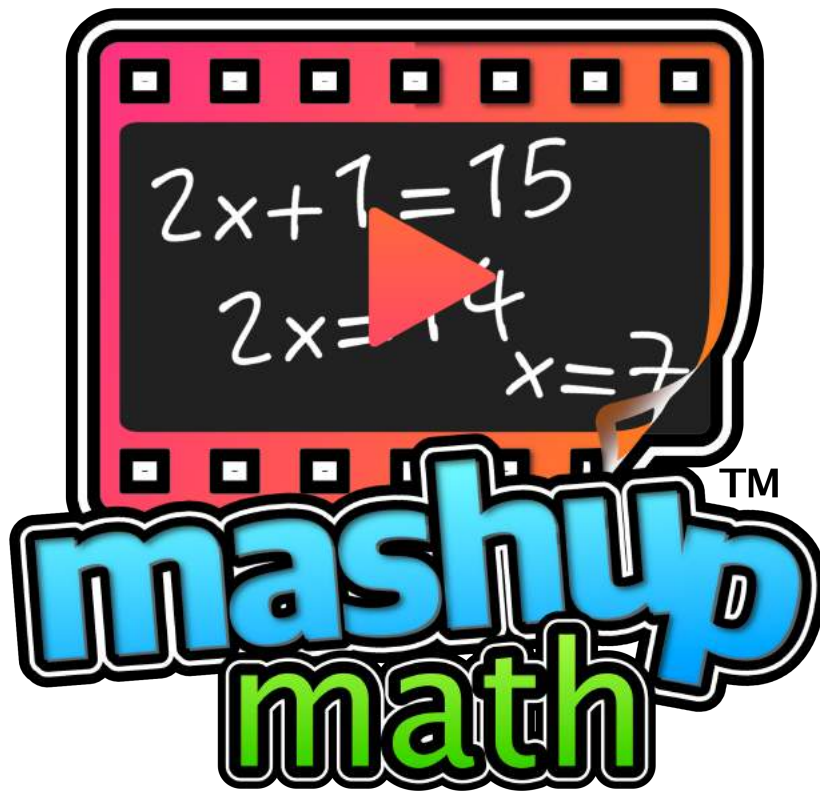


# Mathematics in Baseball

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# How To Teach Students Math Skills Through Baseball

Teachers are constantly seeking creative ways to make learning interesting, engaging, and relevant for their students, especially during the final stretch of the school year.

Spring not only signals the final weeks of school, it also ushers in the start of a new season of Major League Baseball, which offers a great opportunity for students to learn and apply mathematics in a real world context.

Baseball is a sport that is driven by tradition and statistics. Even the casual fan understands the concepts of batting average, fielding percentage, and earned run average.

The analysis of this performance data is used to evaluate a player's performance and has a tremendous impact on rankings, contracts, and awards.

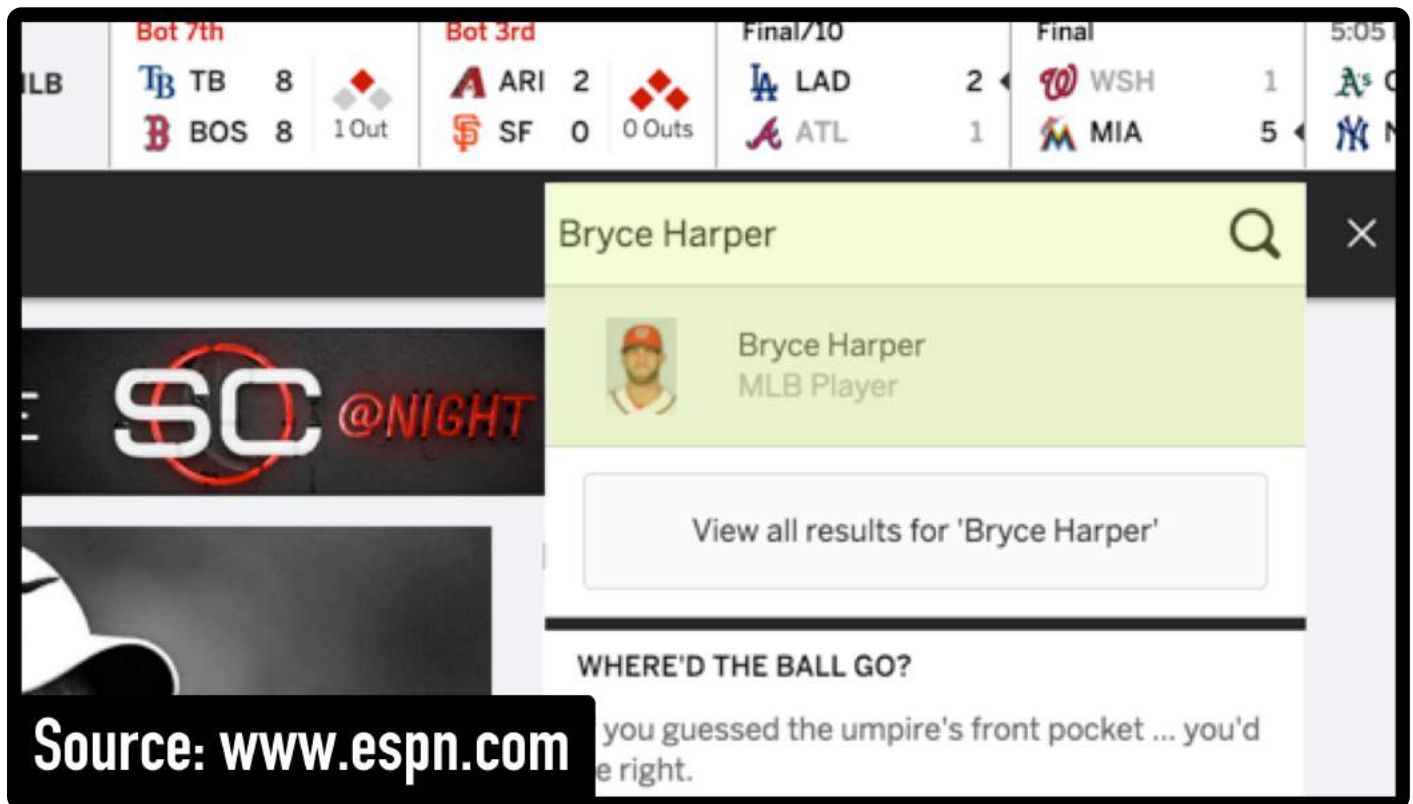
Math teachers can take advantage of their students' enthusiasm for the new baseball season by teaching math concepts like averages, probability, and sample sizes in the context of baseball and the popular statistics that apply to both pitchers and hitters.

In fact, some MLB teams have put this idea into practice by establishing Math & Science in Baseball Summer Camp programs for local students ([HTTP://ABC7.COM/EDUCATION/ANGELS-PROGRAM-TEACHES-KIDS-SCIENCE-MATH-THROUGH-BASEBALL-/879159/](http://abc7.com/education/angels-program-teaches-kids-science-math-through-baseball-/879159/))).

Fortunately, teachers need not access to sponsored programs to share the benefits of teaching mathematics in the context of baseball. The following is a step-by-step guide through an engaging activity, which can be done in the classroom or at home, that gives students the opportunity to calculate the most popular performance statistics of their favorite hitters and pitchers.

# Activity: The Mathematics of Baseball

For this activity, you will need to visit ESPN.com, where you will be able to access the statistical profile of the professional players (past or present) whom you choose to analyze. You will have to choose one hitter and one pitcher and you can access their profiles by using the search feature on their website.



From a player's profile page, click on the STATS tab to access his career performance statistics.

For this example, I will be using **Bryce Harper** of the Washington Nationals as my hitter and the **Noah Syndergaard** of the New York Mets as my pitcher.

**Bryce Harper**  
 #34 RF | Bats: L, Throws: R | Washington Nationals  
 Birth Date: October 16, 1992 (Age: 23)  
 Birthplace: Las Vegas, NV  
 Experience: 4 years  
 College: South Carolina  
 Ht/Wt: 6-3, 216 lbs.

2016 Season  

AVG	HR	RBI	OBP
.321	8	22	.406

 Career  

.290	104	269	.385
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 Go to: Bryce Harper

Player Profile **Stats** Splits Game Log Bat vs Pitch Hot Zones Videos Photos Shop

WASHINGTON'S PREVIOUS GAME  
 Final Thu, Apr 21 Washington (11-4) **1-5** MIAMI (5-9) Marlins Park  
[Recap](#) [Box Score](#)

STATS	AB	R	H	2B	3B	HR	RBI	BB	AVG
This Game	4	1	1	0	0	1	1	0	.250
Last seven days	25	6	10	1	0	5	16	2	.400
April	49	11	16	4	0	7	21	9	.327
	0	5	10	3					.308

Source: [www.espn.com](http://www.espn.com)

*\*Note that all statistics referenced are as of 4/21/2016. Any changes in data are a result of games played after the posting date.*

# -Batting Statistics Analysis-

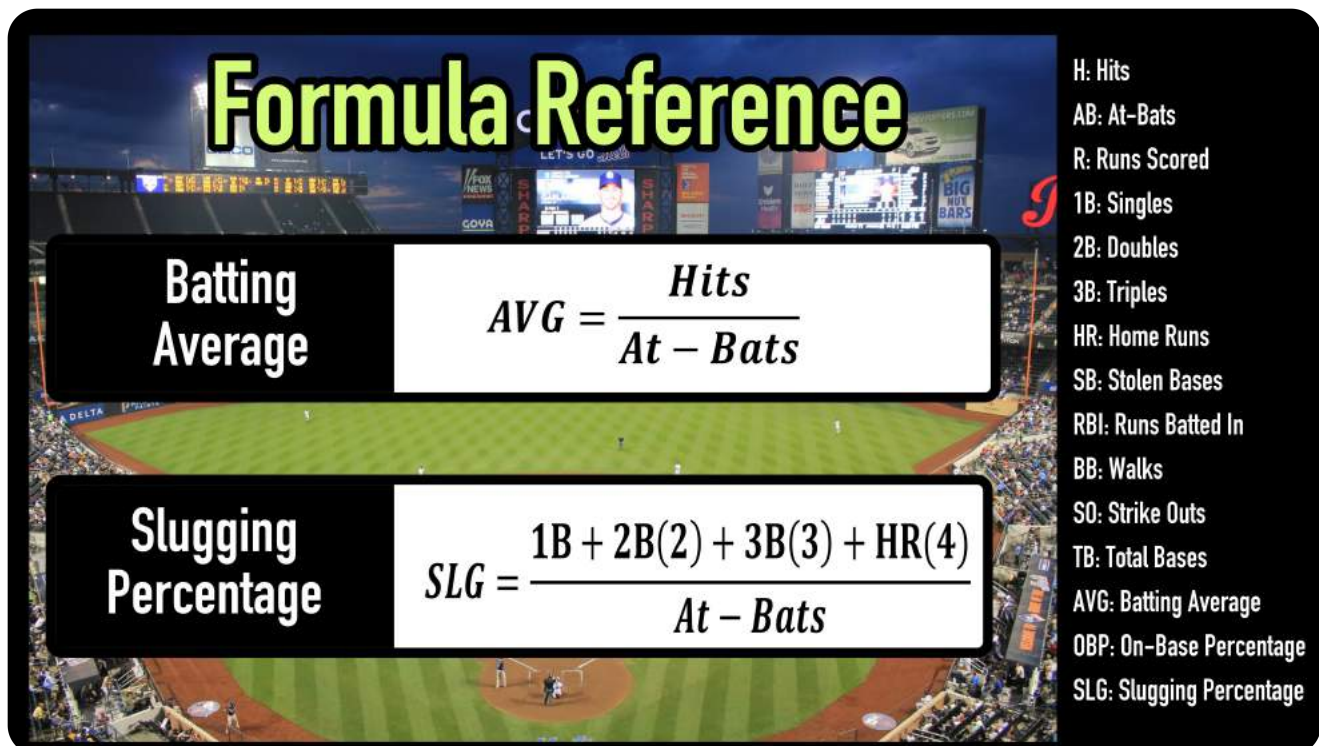
Once you have your player's performance data handy, you will be able to calculate the following performance statistics:

- **Batting Average (AVG):** The likeliness that a player will get a hit in any given at-bat.
- **Slugging Percentage (SLG):** Measures a hitter's power by weighing hits based on the total number of bases. For example, a triple would be worth three times as much as a single.

*\*Note that each of these statistics are reported to three decimal places. A player with an AVG of .300 is considered to have a batting average of three hundred.*

## Batting Stats Calculation

Now you are ready to perform your calculations with the aid of the following formulas:

A graphic titled "Formula Reference" set against a background of a baseball stadium at night. It contains two formula boxes and a legend. The first box shows the formula for Batting Average (AVG) as Hits divided by At-Bats. The second box shows the formula for Slugging Percentage (SLG) as (1B + 2B(2) + 3B(3) + HR(4)) divided by At-Bats. The legend on the right lists abbreviations for Hits, At-Bats, Runs Scored, Singles, Doubles, Triples, Home Runs, Stolen Bases, Runs Batted In, Walks, Strike Outs, Total Bases, Batting Average, On-Base Percentage, and Slugging Percentage.

**Formula Reference**

**Batting Average**

$$AVG = \frac{Hits}{At - Bats}$$

**Slugging Percentage**



$$SLG = \frac{1B + 2B(2) + 3B(3) + HR(4)}{At - Bats}$$

**Legend:**

- H: Hits
- AB: At-Bats
- R: Runs Scored
- 1B: Singles
- 2B: Doubles
- 3B: Triples
- HR: Home Runs
- SB: Stolen Bases
- RBI: Runs Batted In
- BB: Walks
- SO: Strike Outs
- TB: Total Bases
- AVG: Batting Average
- OBP: On-Base Percentage
- SLG: Slugging Percentage

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Lets begin by calculating Bryce Harper's career batting average. To find this stat, you will be focusing on his career statistics, which are compiled in the TOTAL row at the bottom of the statistics table on his player profile.

CAREER BATTING STATISTICS																		
YEAR	TEAM	GP	AB	R	H	2B	3B	HR	RBI	BB	SO	SB	CS	AVG	OBP	SLG	OPS	WAR
2012	 WSH	139	533	98	144	26	9	22	59	56	120	18	6	.270	.340	.477	.817	5.0
2013	 WSH	118	424	71	116	24	3	20	58	61	94	11	4	.274	.368	.486	.854	3.8
2014	 WSH	100	352	41	96	10	2	13	32	38	104	2	2	.273	.344	.423	.767	1.0
2015	 WSH	153	521	118	172	38	1	42	99	124	131	6	4	.330	.460	.649	1.109	9.9
2016	 WSH	14	49	11	16	4	0	7	21	9	6	3	0	.327	.417	.837	1.254	--
<b>Total</b>	<b>Total</b>	<b>524</b>	<b>1879</b>	<b>339</b>	<b>544</b>	<b>102</b>	<b>15</b>	<b>104</b>	<b>269</b>	<b>288</b>	<b>455</b>	<b>40</b>	<b>16</b>	<b>.290</b>	<b>.385</b>	<b>.526</b>	<b>.911</b>	<b>--</b>
<b>Season Averages</b>		<b>104.0</b>	<b>375.8</b>	<b>67.8</b>	<b>108.8</b>	<b>20.4</b>	<b>3.0</b>	<b>20.8</b>	<b>53.8</b>	<b>57.6</b>	<b>91.0</b>	<b>8.0</b>	<b>3.2</b>	<b>.290</b>	<b>.385</b>	<b>.526</b>	<b>.911</b>	<b>--</b>

To find Bryce Harper's career batting average, you will need to divide his 544 career hits by his 1879 career at-bats:

$$544 \div 1879 = 0.289515699 \dots$$

And since batting average is reported to the third decimal place, you can confirm that he has a career AVG of **.290**.

This statistic tells us that Harper will collect, on average, 290 hits for every 1,000 at-bats.

**ANALYSIS QUESTION**

Based on his career AVG, how many hits would you expect Bryce Harper to collect over 450 at-bats?

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To calculate Harper's slugging percentage (SLG), you will have to first calculate his total bases (TB). To find TB, you will need to know the total number of singles, doubles, triples, and home runs he has. From his profile, you can see that he has 102 doubles, 15 triples, and 104 home runs, for a sum of 221 extra-base hits.

To find the number of singles, simply subtract this sum from his 544 total hits, to get 323.

Now you are ready to calculate the numerator of the formula. Notice that singles (1B) are only counted once, doubles (2B) are counted twice, triples (3B) are counted thrice, and home runs (HR) are weighted four times!

$$\text{So we have: } 323(1) + 102(2) + 15(3) + 104(4) = 988$$

Finally, you divide the 988 total bases by 1879 career at-bats, for a slugging percentage of **.526** !



How does Bryce Harper's career SLG match up with Dexter Fowler of the Chicago Cubs, Josh Donaldson of the Toronto Blue Jays, and David Ortiz of the Boston Red Sox?

# -Pitching Statistics Analysis-

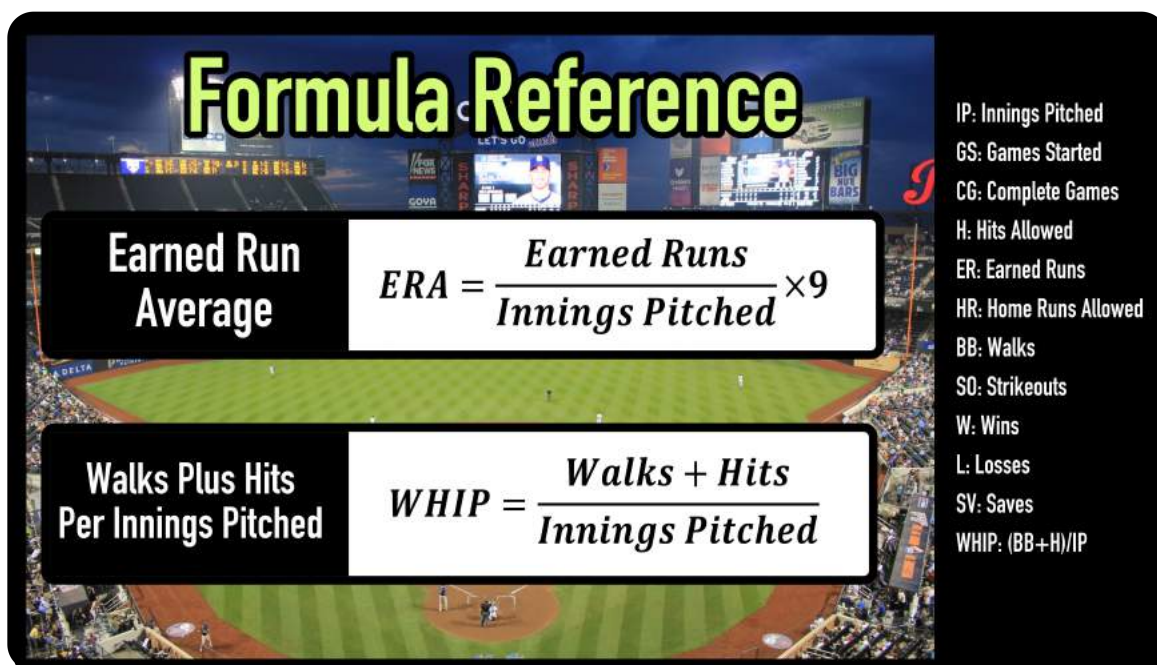
Now you will reference your pitcher's profile page. Pitchers play a unique position and have their own performance statistics, two of which you will learn to find:

- **Earned Run Average (ERA):** The mean number of earned runs scored against a pitcher per nine innings pitched. An ERA of 3.00 would mean that, on average, a pitcher allows three runs per nine innings pitched.
- **Walks Plus Hits Per Innings Pitched (WHIP):** Reflects how difficult it is for a batter to reach base against a pitcher. The lower a pitcher's WHIP, the more difficult it is to reach base against him.

*\*Note that each of these statistics are reported to the second decimal place.*

## Pitching Stats Calculation

Now you are ready to perform your calculations with the aide of the following formulas:



The graphic features a baseball stadium at night with a scoreboard and advertisements. The title "Formula Reference" is at the top in green. Below it, two boxes show the formulas for ERA and WHIP. To the right, a list of abbreviations is provided.

**Earned Run Average**

$$ERA = \frac{\text{Earned Runs}}{\text{Innings Pitched}} \times 9$$

**Walks Plus Hits Per Innings Pitched**

$$WHIP = \frac{\text{Walks} + \text{Hits}}{\text{Innings Pitched}}$$

IP: Innings Pitched  
GS: Games Started  
CG: Complete Games  
H: Hits Allowed  
ER: Earned Runs  
HR: Home Runs Allowed  
BB: Walks  
SO: Strikeouts  
W: Wins  
L: Losses  
SV: Saves  
WHIP: (BB+H)/IP



You will also need to reference your pitcher's statistic profile. I have chosen to analyze **Noah Syndergaard** of the New York Mets.

**Noah Syndergaard**  
#34 SP | Throws: R, Bats: L | New York Mets

Birth Date: August 29, 1992 (Age: 23)  
Birthplace: Mansfield, TX  
Experience: 1 year  
College: None  
Ht/Wt: 6-6, 242 lbs.

2016 Season  
ERA: 0.90 | W-L: 2-0 | SO: 29 | WHIP: 0.95

Career  
2.96 | 11-7 | 195 | 1.04

Go to: Noah Syndergaard

Player Profile | Stats | Splits | Game Log | Bat vs Pitch | Hot Zones | Videos | Photos | Shop

### Noah Syndergaard Stats

Pitching | Fielding | Batting

PITCHING STATISTICS																				
SEASON	TEAM	GP	GS	CG	SHO	IP	H	R	ER	HR	BB	SO	W	L	SV	HLD	BLSV	WAR	WHIP	ERA
2015	NYM	24	24	0	0	150.0	126	60	54	19	31	166	9	7	0	0	0	2.1	1.05	3.24
2016	NYM	3	3	0	0	20.0	15	2	2	0	4	29	2	0	0	0	0	--	0.95	0.90
Total	--	27	27	0	0	170.0	141	62	56	19	35	195	11	7	0	0	0	--	1.04	2.96
Season Averages		13.0	13.5	.0	.0	85.0	70.5	31.0	28.0	9.5	17.5	97.5	5.5	3.5	.0	.0	.0	--	1.04	2.96

To find Syndergaard's career ERA, you will need to divide his total career earned runs (ER) by innings pitched (IP) and then multiply that quotient by 9:

$$(56 \div 170.0) \times 9 = 2.96470588 \dots$$

So you can conclude that he has a career ERA of **2.96**.

## Earned Run Average By Comparison

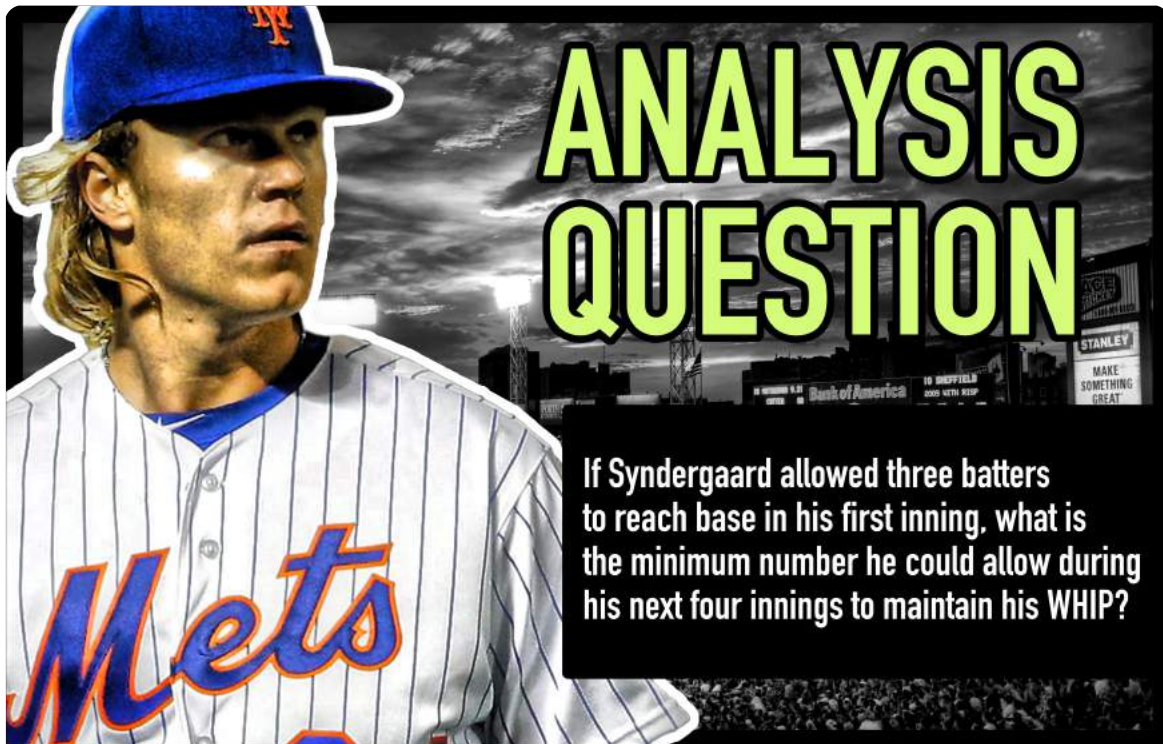


How does Syndergaard's ERA rank amongst Felix Hernandez of the Seattle Mariners, Clayton Kershaw of the Los Angeles Dodgers, and Dellin Betances of the New York Yankees?

Finally, we can calculate Syndergaard's WHIP by first adding his total walks (BB) and hits allowed (H), and then dividing the sum by his total innings pitched (IP):

$$(35 + 141) \div 170 = 1.03529411 \dots$$

You can conclude that Syndergaard has a WHIP of approximately **1.04**, which means that he allows, on average, about one batter to reach base.



# ANALYSIS QUESTION

If Syndergaard allowed three batters to reach base in his first inning, what is the minimum number he could allow during his next four innings to maintain his WHIP?

## Conclusion

Learning math in the context of sports statistics is an awesome way to engage students and to expose them to real-world applications. This activity only scratches the surface of calculating baseball statistics and using them to evaluate and compare the performances of your favorite players.

***By Anthony Persico***

Anthony is the content crafter and head educator for MashUp Math. You can often find me happily developing animated math lessons to share on my [YouTube channel](https://www.youtube.com/mashupmath) ([www.youtube.com/mashupmath](https://www.youtube.com/mashupmath)). Or spending way too much time at the gym or playing on my phone.



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