# More Power to Ya!

ID: 11303

Time Required
*10–15 minutes*

## Activity Overview

*In this activity, students will use the Calculator application to explore the Power Rule. For each of the four examples, they will first examine “true” statements about various derivatives of $x^n$ where* n *is an integer. They will observe patterns, and use these patterns to create a rule for finding the derivative of $x^n$ with respect to $x$. They will then use their rule to create examples of their own.*

## Topic: Power Rule

- *Derivative of $x^n$ with respect to* x
- *Definition of a derivative*

## Teacher Preparation and Notes

- *This activity uses the $\frac{d}{dx}f(x)$ notation to denote the derivative. Some students may attempt to type the letter d in the numerator of a fraction and ‘dx’ in the denominator. This will not work. In the Calculator application, this notation can be found in the Calculus menu (**MENU > Calculus > Derivative**). Alternatively, you may find the derivative template in the templates menu in the catalog, .*
- ***To download the student TI-Nspire document (.tns file) and student worksheet, go to education.ti.com/exchange and enter “11303” in the quick search box.***

## Associated Materials

- *MorePowerToYa_Student.doc*
- *MorePowerToYa.tns*

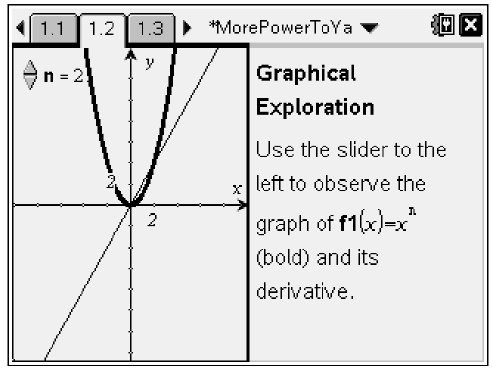
## Suggested Related Activities

*To download any activity listed, go to* education.ti.com/exchange *and enter the number in the quick search box.*

- *The Derivative of a Polynomial (TI-Nspire technology) — 9858*

**Problem 1 – Graphical Exploration**

Students are to use the slider to observe the graph of $f(x) = x^n$ and its derivative. Students should begin to predict the relationship between $x^n$ and its derivative.



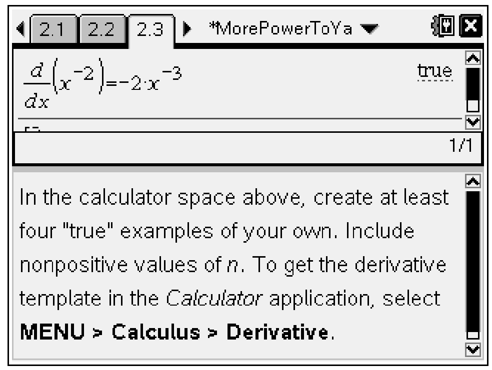

***Student Solutions***

- The degree of the derivative is one less than that of the original function.

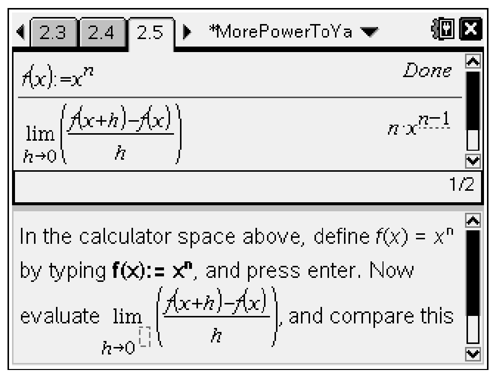
**Problem 2 – Defining the Derivative of $x^n$**

On page 2.2, students are to examine four true statements of the derivative of $x^n$ with respect to $x$ where $n$ is an integer. They are then asked to observe any patterns. After coming up with a pattern, students will test several examples of their own on page 2.3.

Students should create a rule for taking the derivative of $x^n$ that fits the given examples and the examples that they created.




Students are asked to use the calculator space at the top of the page to find the derivative of $x^n$ with respect to $x$, using the definition of a derivative. They are to compare this result with the result found on page 2.4. Students should be aware that this result is called the Power Rule.



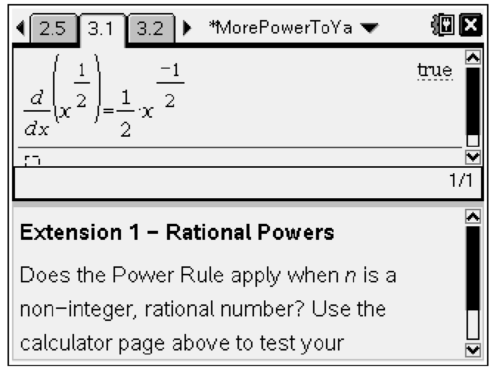

*Note:* If the variable $n$ is already defined, the results will not be correct. The value for the variable can be deleted using the command **delvar *n*** in the Calculator screen.

***Student Solutions***

- The exponent becomes the coefficient of $x$ and the degree is one less.Sample answers: $\frac{d}{dx}x^6 = 6\cdot x^5$, $\frac{d}{dx}x^7 = 7\cdot x^6$, $\frac{d}{dx}x^{-2} = -2\cdot x^{-3}$, $\frac{d}{dx}x^{-3} = -3\cdot x^{-4}$
- Sample answer: $\frac{d}{dx}x^n = n\cdot x^{n-1}$
- Sample answer: The result is the same as the rule I found.

## Extension

Students are asked if the Power Rule applies when *n* is a non-integer, rational number. They should use the calculator space on page 3.1 to test their conjecture.




### *Student Solution*

- Yes, the Power Rule also applies when *n* is a non-integer, rational number.
  For example, $\frac{d}{dx}x^{\frac{1}{2}}=\frac{1}{2}x^{-\frac{1}{2}}$

Students are asked to, expand the binomial $(x + h)^n$ on a separate piece of paper. They will use this to evaluate the limit they entered on page 2.5 by hand to prove the Power Rule.

**Student Solution**

- $\lim\limits_{h\to 0}\frac{(x+h)^n - x^n}{h}$

$$= \lim_{h\to 0}\frac{\left({}_nC_0x^n + {}_nC_1x^{n-1}h + {}_nC_2x^{n-2}h^2 + \ldots + {}_nC_{n-1}xh^{n-1} + {}_nC_nh^n\right) - x^n}{h}$$

$$= \lim_{h\to 0}\frac{\left({}_nC_1x^{n-1}h + {}_nC_2x^{n-2}h^2 + \ldots + {}_nC_{n-1}xh^{n-1} + {}_nC_nh^n\right)}{h}$$

$$= \lim_{h\to 0}\frac{h\left({}_nC_1x^{n-1} + {}_nC_2x^{n-2}h + \ldots + {}_nC_{n-1}xh^{n-2} + {}_nC_nh^{n-1}\right)}{h}$$

$$= \lim_{h\to 0}\left({}_nC_1x^{n-1} + {}_nC_2x^{n-2}h + \ldots + {}_nC_{n-1}xh^{n-2} + {}_nC_nh^{n-1}\right)$$

$$= {}_nC_1x^{n-1}$$

$$= n \times x^{n-1}$$

where ${}_nC_r = \frac{n!}{(n-r)!\cdot r!}$