Rate of Change in Python	Grade 12 Understanding rates of change

Lesson Plan

Description

Students will use a graph provided or select a real-world situation that can be modelled by a quadratic function. Students will then use Python coding language to create a program that evaluates the function at any two given points and calculates the average rate of change.

Learning Outcomes

- Rate of change as a measure of the change
- An average rate of change is a change that takes place over an interval.
- A program as a set of instructions in a programming language for a computer to execute.
- Introduction to the Python coding language

Specific Expectations

MHF4U – Characteristics of functions

D1.2 recognize that the rate of change for a function is a comparison of changes in the dependent variable to changes in the independent
variable, and distinguish situations in which the rate of change is zero, constant, or changing by examining applications, including
those arising from real-world situations

D1.4 calculate and interpret average rates of change of functions (e.g., linear, quadratic, exponential, sinusoidal) arising from real-world applications (e.g., in the natural, physical, and social sciences), given various representations of the functions (e.g., tables of values, graphs, equations)

Introduction

Rate of change can be defined as a measure of the change in one quantity with respect to a change in another quantity. In the field of STEM these quantities are represented as the dependent (y) and independent (x) variables.

An average rate of change is a change that takes place over an interval in any given function and corresponds to the slope of a secant line between that interval. A secant line is a line that passes through two points on the graph of a relation.

It is important to note that since all linear relations have a constant rate of change, calculations involving different intervals in these relations give the same result.

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For this lesson, the focus will be on non-linear relationships. Non-linear relationships have different rates of change over different intervals.

Students may select a situation for which they either have a graph or a set of data which they can model using a quadratic equation. This could be represented as a parabolic motion such as a golf shot or basketball shot, or alternatively, a quadratic relationship may be provided.

Once students have acquired their quadratic relationship, their task is to create a computer program using the Python language that can evaluate the relationship at any given point and calculates the average rate of change.

Students will explore basic Python commands as an introduction to language-based coding as opposed to block-based languages.

This activity may be performed in strategic groups, individually, or any other configuration.

Action (Please see the slide for detailed student instruction)

To be successful in this activity, students will first need to understand the process of evaluating using functions and finding rates of change.

First the student will select their situation and create a model equation that will be used to evaluate the given points within the program.

Next, the student will use a Python compiler to begin creating their program. Science North recommends Replet for using Python online. The program should be able to evaluate their model at two values of x and store each value as a variable.

Lastly, the program should use these values to calculate the average rate of change over that interval.

Students will explore the following commands

print – Allows the program to display a given sequence of characters

"variable" = allows the user to assign a value to a given variable

input allows the program to receive an input from the current user

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float / str / int – establishes the type of data for the program to interpret

* Multiplication

+ addition

- subtraction

** power / exponent

Consolidation/Extension

- Students can be challenged by changing the type of function used. (cubic, quartic, etc)
- As an alternative, create an almost functional program and ask students to figure out how to get the program to run correctly. (Important to note that Python is case sensitive and commas are important to separate terms in parentheses)
- Have students use the program to explore the relationship between average rate of change and instantaneous rate of change.

Accommodations/Modifications

- Use this as a tool to verify their calculations
- Students may start by coding linear functions, the base graph of a quadratic, (x^2) then move on to larger polynomials.

Assessment

- Assess student's ability to write using Python programming language
- Assess student's ability to describe average rate of change, secant and tangent lines, and instantaneous rates of change.

Additional Resources

https://www.python.org/
https://replit.com/languages/python3
https://wiki.python.org/moin/BeginnersGuide
https://docs.python.org/3/tutorial/introduction.html#using-python-as-a-calculator
https://www.online-python.com/ - Online compiler
https://wiki.python.org/moin/BeginnersGuide/NonProgrammers

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