The SAMR Model: TinkerPlots

Ministry Licensed Resource Title:	TinkerPlots
Description of resource	Tinkerplots is software that allows students to build their own plots to analyze data. Tinkerplots is especially useful for mathematics teachers and in inquiry-based science and social science classrooms where students collect and analyze data as part of formulating and testing their own hypotheses. Students can explore their graphs to identify common measures such as the mean, median, mode, and more. In addition, they can drag an outlier and watch these measures change dynamically. Through a colorful, interactive interface, the software encourages students to tinker with data to see various relationships. Data coloring helps students detect subtle relationships in their data. Students can create, import, download data or investigate more than 40 data sets included with TinkerPlots. Using the construction set students can graph data in multiple ways including dot plots, map graphs, histograms, scatter plots, and box graphs. Students can highlight a case in one graph and see where it is in all the other graphs. They can add text and pictures, turning a TinkerPlots file into a colorful report for communication. A collection of resources, tutorials and videos to help with TinkerPlots can be found at: http://www.keycurriculum.com/products/tinkerplots/tinkerplots-resources
Curriculum Connections	This exemplar is specific to Grade 9 Science (Applied and Academic), but could be used in any area where the analysis of data and graphical form of communication can be used to draw conclusions. This will be a natural fit for inquiry-based science or social science classes where data is being collected and analyzed.

	SNC1D - Grade 9 Science, Academic Overall Expectation: A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating); Specific Expectations: A1.6 gather data from laboratory and other sources, and organize and record the data using appropriate formats, including tables, flow charts, graphs, and/or diagrams A1.7 select, organize, and record relevant information on research topics from various sources, including electronic, print, and/or human sources (e.g., Statistics Canada publications, NASA or EnerGuide websites, personal interviews), using recommended formats and an accepted form of academic documentation A1.8 analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty Overall Expectation: B2. investigate factors related to human activity that affect terrestrial and aquatic ecosystems, and explain how they affect the sustainability of these ecosystems; Specific Expectations: B2.2 interpret qualitative and quantitative data from undisturbed and disturbed ecosystems (terrestrial and/or aquatic), communicate the results graphically, and, extrapolating from the data, explain the importance of biodiversity for all sustainable ecosystems [PR, AI, C] **and/or,** B2.5 analyse the effect of human activity on the populations of terrestrial and aquatic ecosystems by interpreting data and generating graphs (e.g., data from Statistics Canada, Parks Canada, and other websites on: the concentration in water of chemicals from fertilizer run-off and their effect on the growth of algae; stressors associated with human use of natural areas, such as trampled vegetation, wildlife mortality from motor vehicles, and the removal

	of plants, animals, and/or natural objects; suburban developments and their impact on the food supply for animals such as foxes and racoons) [PR, AI, C] **SNC1P - Grade 9 Science, Applied** Overall Expectation: A1. demonstrate scientific investigation skills (related to both inquiry and research) in the four areas of skills (initiating and planning, performing and recording, analysing and interpreting, and communicating); Specific Expectations: A1.6 gather data from laboratory and other sources, and organize and record the data using appropriate formats, including tables, flow charts, graphs, and/or diagrams A1.7 select, organize, and record relevant information on research topics from various sources, including electronic, print, and/or human sources (e.g., Statistics Canada publications, NASA or EnerGuide websites, personal interviews), using recommended formats and an accepted form of academic documentation A1.8 analyse and interpret qualitative and/or quantitative data to determine whether the evidence supports or refutes the initial prediction or hypothesis, identifying possible sources of error, bias, or uncertainty Overall Expectation: B2. investigate some factors related to human activity that affect terrestrial or aquatic ecosystems, and describe the consequences that these factors have for the sustainability of these ecosystems; Specific Expectations: B2.3 compile and graph qualitative and quantitative data on organisms within an undisturbed or disturbed ecosystem (terrestrial or aquatic) (e.g., nematode and earthworm populations in soil or compost; bird populations during migration or winter feeding; tadpole and mosquito larvae populations in a local pond) [PR, AI, C] **and/or,** B2.5 analyse the effect of factors related to human activity on terrestrial or aquatic ecosystems by interpreting data and generating

	graphs (e.g., data on the concentration in water of chemicals from fertilizer run-off and their effect on the growth of algae) [AI, C]
The "traditional" classroom practice and approach to the learning goals	Providing data to students about specific situations (some examples below). Students graph the data and answer a series of questions requiring interpretation of the data. Completed work is handed in to the teacher for feedback and/or taken up as a class. Examples: • wolf population and deer population over time • moose-vehicle accidents and moose population over time • water quality indicators (chemicals) over time or in a variety of locations human population density vs. small animal population density (squirrels, racoons, etc.)
SAMR: Substitution	Students use TinkerPlots to graph the data provided and answer a series of questions about the relationships found in the given data. Different student graphs and conclusions are shared with the class through the use of a projector.
SAMR: Augmentation	Students use TinkerPlots to graph data and create a report within TinkerPlots to communicate their findings. Instead of answering a series of questions leading students through data analysis, students communicate their findings to an audience of their peers. Reports are shared with the class digitally or by printing them.
SAMR: Modification	Provide students with a large set of data with multiple indicators (example: PWQMN Data, which includes data about water quality testing from different stream stations all over Ontario). Different groups of students pose different questions and use TinkerPlots to manipulate and analyze the data to answer their questions. Questions could include "how does latitude/time of year impact metal concentration/dissolved oxygen level of water?". Students present their findings to the class, including their data analysis. This activity allows students to pose their own inquiry questions and then see how each group used TinkerPlots to analyze the data through presentations.
SAMR:	**Option 1: Sharing Beyond the Classroom**

Redefinition	Provide students with a large set of data with multiple indicators (example: wolf population, deer population, climate data, plant growth data, etc. over time). Different groups of students pose different questions and use TinkerPlots to manipulate and analyze the data to answer their questions. Students create digital presentations to share their findings to a class blog or website. These digital presentations could include recorded presentations, infographics or screen captures of their data analysis using TinkerPlots. This work can now be shared with a wider audience including collaborations with other classes, environmental advocates, politicians or scientists. **Option 2: Inquiry-Driven** With guidance, students pose a question they have about human impact on an ecosystem. For example: "how does the latitude of a stream water testing location impact the metal concentration/pH?" or, "how does wildlife-vehicle accidents impact wildlife populations?". Students gather data through research and use TinkerPlots to analyze the data. Students create digital presentations to share their findings to a class blog or website. These digital presentations could include recorded presentations, infographics, videos or screen captures of their data analysis using TinkerPlots. This work can now be shared with a wider audience including collaborations with other classes, environmental advocates, politicians or scientists. Notes: • this activity will have students practice the skill of searching databases for data (may require scaffolding for some) • possible data resource for this example: PWQMN Data. **Option 3: Global Collaboration Inquiry** Data is collected globally and collaboratively by students about water quality. Students create a google spreadsheet (or google form) to collect data about locations and water quality from around the world. Data collected could include: air temperature, water temperature, date, latitude, longitude, local population density, pH, species

	present, etc. This data set is then imported into TinkerPlots for analysis as a class or in small groups. As students find regions around the world/county/province/country with higher or lower pH levels, they could interview students from that area about local geography, industry, waste control methods, etc. Using research and through interviewing students from those areas, students could develop theories explaining the increase or decrease in pH levels along with ideas for improving or stabilizing water quality. Students' final product would include data from their survey (analyzed in TinkerPlots), a discussion about the impact of human activity on that aquatic ecosystem and suggestions for possible stabilization or improvement of water quality (including the barriers to those solutions). Notes: • A project like this would require the teacher be connected to a professional learning network of other educators, allowing them to gather data from different locations. These professional learning networks could be developed informally through social networks like Twitter, or through an organization such as iEARN, CurioCity or TakingITGlobal. • If students in other countries did not have access to pH testing equipment, students in Canada could help them create their own indicators or by sending them pH paper. • Adaptations include: gather data from local areas vs. globally (example: all over Simcoe County, all over Ontario or throughout Canada) • Students may have to combine data sources such as the population of an animal and the average temperature for a season in a particular region Other Data Sources: • Transport Canada (wildlife-vehicle accidents): http://www.tc.gc.ca/eng/motorvehiclesafety/tp-tp14798-1289.htm • Wolves and Moose of Isle Royale: http://www.isleroyalewolf.org/data/data/home.html

	• Stats Canada: http://www.statcan.gc.ca/start-debut-eng.html • Canada Climate Data: http://climate.weather.gc.ca/ • Environment Canada Data: http://www.ec.gc.ca/scitech/default.asp?lang=En&n=EE731FE6-1 • York University (information and links to data and statistics): http://researchguides.library.yorku.ca/content.php?pid=227895&sid=1894134 • Environment Canada Ecological Monitoring: http://www.ec.gc.ca/faunescience-wildlifescience/default.asp?lang=En&n=B0D89DF1-1 • WWF Polar Bear FactSheet: http://www.wwf.ca/conservation/species/polar_bear_factsheet.cfm
Considerations for Digital Citizenship:	• Students will need to be aware of proper sourcing for data used. • If images, music or screen captures are used to create presentations, students will need to be able to properly find and provide attribution for media licensed through creative commons. • This activity will provide a great base for practicing the skill of evaluating information sources found on the Internet. • Searching databases effectively is a skill that could be developed through this activity. Posting presentations on a class or school blog or website and collaborating with experts, other students, environmental advocates or politicians online will provide opportunity for the practical application of digital safety and privacy concerns.