Grade 6 Mathematics
Investigation – Investigating Temperature Extremes

Indicator: *6N1, 6N2, and 6MD2--Compare, order, model and calculate with whole numbers, fractions, decimals, and percentages, recognise the properties of numbers, apply a range of strategies to aid computation, and use and interpret times, timetables and timelines.*

Learning Outcomes: Students will analyse temperature extremes using web based mapping tools to:

6N1.1 – Understand, explain, and use the place value of positive numbers of any size by analysing data about extreme temperatures using web-based mapping tools.
6N1.2 – Round numbers to the nearest 10, 100 and 1000 and justify rounding in terms of closeness to the number
6N1.3 – Order and compare whole numbers of any size in ascending and descending order, including positive and negative numbers.
6N1.4 - Describe, visually represent and use a variety of numeracy strategies for addition, subtraction, multiplication and division.
6N1.5 - Select and apply an appropriate numeracy strategy to solve addition, subtraction, multiplication and division problems and justify the choice of strategy.
6N1.7 - Investigate, visually represent and describe factors and multiples up to 100.
6N2.3 – Model and compare decimals to three decimal places.
6N2.4 – Add and subtract decimal numbers with the same and different number of decimal places.
6MD2.1 – Investigate the units for time (day, week, month, year) and convert between them.
6MD2.5– Draw and interpret timelines to record events.

CAN YOU WORK EFFECTIVELY WITH NUMBERS SO THAT YOU CAN UNDERSTAND EXTREME TEMPERATURES AROUND THE WORLD?

CAN YOU COMPARE AND INTERPRET INFORMATION SO THAT YOU CAN UNDERSTAND PATTERNS OVER SPACE AND TIME?

Teacher Notes:

This is a **discovery** type investigation. Students use live web mapping services in an online Geographic Information System (GIS) and use extreme high and low temperature extremes data around the world, applying mathematical concepts to analyse patterns over space and time.

Students will investigate 8 areas of mathematics in this task:

1. Students will analyse temperature extremes data around the world including the temperature reading and the date.
2. Students will examine the relationship between the location (primarily: Altitude and latitude) of the extreme temperatures and the value of the temperature, and whether that temperature was a high or a low extreme.
3. Students will order and compare numbers in temperature data tables and on maps.
4. Students will round numbers in temperature data tables and maps.
5. Students will visually represent numbers in temperature data tables and maps.
6. Students will add and subtract whole numbers and decimals.
7. Students will compare temperature extremes over time by constructing graphs.

Required time: 3 hours. 20 questions. Setting: Working on a computer.

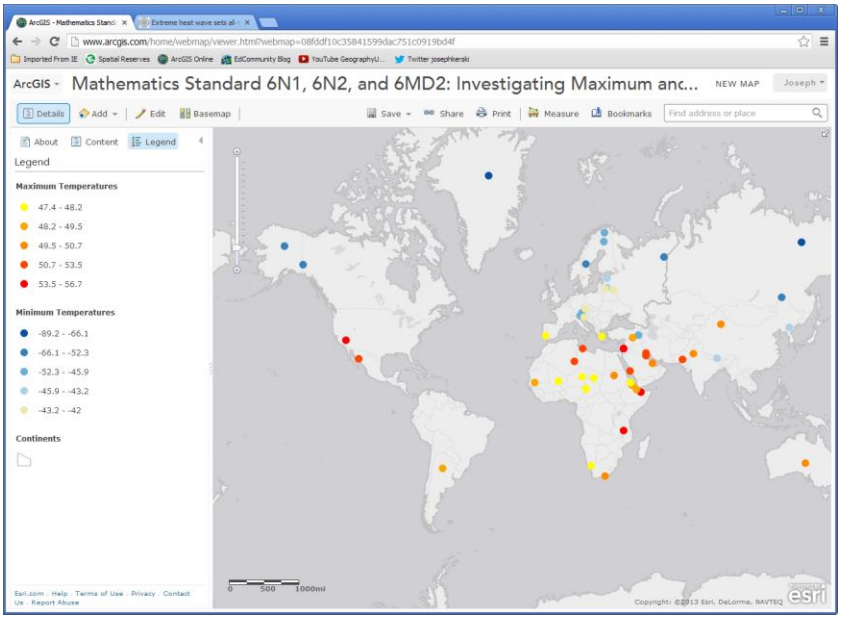
Requirements: Laptop or tablet computer, a web browser, and access to the Internet.

Ideally, each student works on his or her own computer (or in teams of two) using a web browser. Alternatively, but less ideally, the instructor uses 1 computer with a projector and engages the students in questions and dialogue as the lesson is being taught. Students could also work in pairs to complete this activity.

Grade 6 Mathematics
Investigation – Investigating Temperature Extremes

Student names: **Class:**

Students have 3 class periods to complete the following investigation. The investigation is to be completed individually or in teams of two.	

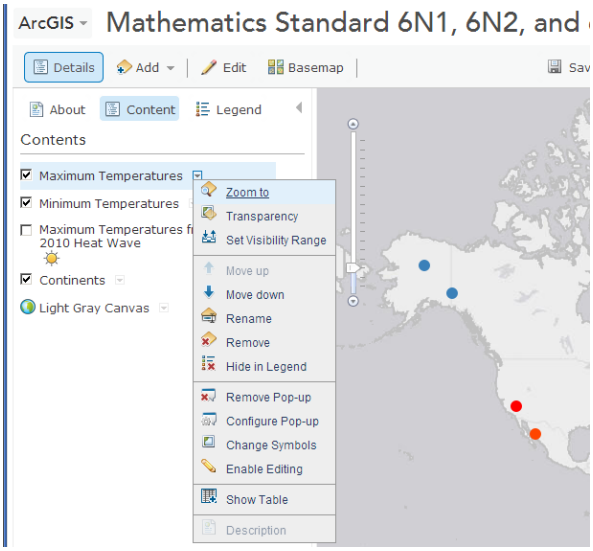
Open a web browser. Enter the following address in a web browser: http://bit.ly/12Q9MaG. The map that opens is a world map entitled "Mathematics Standard 6N1, 6N2, and 6MD2: Investigating Maximum and Minimum Temperature Extremes." It is a world map showing temperature extremes (locations where the hottest and coldest temperatures on Earth have been recorded), as follows: 	

You will use this live web map that is created with a Geographic Information System (GIS). A GIS provides an excellent way to explore the world and to learn mathematics at the same time. This	

map is served via a web based GIS called ArcGIS Online.

Use your mouse to move the map by clicking on the map and moving the mouse. Zoom in and out on the map using the slider bar on the left side of the map. You can also zoom in by pressing the Shift key while dragging a box across the map with the mouse, and letting go with the mouse. You can use the Bookmarks to zoom to the locations identified there, as well.

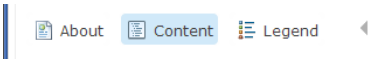
You can also show the table of data associated with each map layer. With the Content tab selected, click the arrow to the right of any of the map layers and highlight "Show Table", as follows:



Missing data items are usually indicated by a "0" in the table

When you are done interacting with the map, use the bookmark titled "World" to zoom back to the whole world.

Click on "Content" and "Legend" buttons above the table of contents to the left of the map to toggle between the content of the map layers and the legend, as follows:



1. Think about the hottest day you have ever experienced. Where were you located on this day? What did you do to try to cool off?	

2. Estimate the temperature on that hot day and indicate it here: _____. What is the difference between the temperature that day and the maximum temperature shown on this map? Show your work.	
3. Now think about the coldest day you have ever experienced. Where were you located on this day? What did you do to try to warm up?	

4. Estimate the temperature on that cold day and indicate it here: _____. What is the difference between the temperature that day and the minimum temperature shown on this map? Show your work.	

5. Examine the pattern of maximum and minimum temperatures on your map. Click on locations to discover more information about them. Name 2 factors that you think influences the climate in a particular location.	

6. What is the difference between the maximum temperature shown on this map that the planet has ever experienced and the minimum temperature that the planet has ever experienced?	

7. What is the **range** of **maximum** temperatures shown on this map (between the lowest maximum and the highest maximum)? How many times hotter is the highest maximum temperature than the lowest maximum temperature? Round your final answer to the nearest degree. Show your work.	

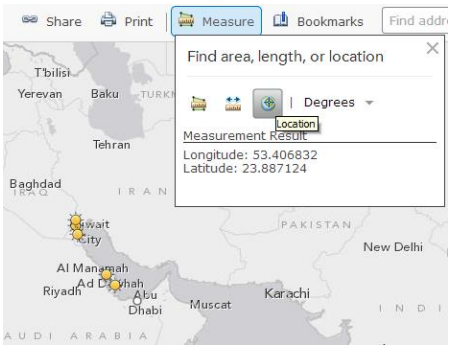
8. How many fields exist in the maximum temperatures data table? By which field is the table sorted?	
9. Change the sorting of this table by clicking on the column heading "Year" and sorting in ascending order. What is the total range of years represented by this table of data?	
10. How many years ago did the all-time maximum temperature occur on the Earth? Select it in the table. You should see its symbology change on the map as well. Zoom to it on the map. Click on the continent in which it is located. In what continent is it located? In what country is it located?	
Latitude on the Earth's surface runs from -90 degrees at the South Pole to +90 degrees at the North Pole, with the Equator running at 0 degrees latitude. Positive latitude values indicate the Northern Hemisphere (north of the Equator) while negative latitude values indicate the Southern Hemisphere (south of the Equator). **11.** Sort the table in Ascending order on Latitude. Are extreme hot temperatures more common in the Northern Hemisphere or in the Southern Hemisphere? Examine the location of the hot temperatures and name a reason why so many hot temperatures occur in that hemisphere. Name the location of the hot temperature that is closest to any pole (either North Pole or South Pole).	

Examine the Month field. In this data table, the months are numbered, from 1 in January to 12 in December. It is summer in the Northern Hemisphere primarily during months 6, 7, and 8 (June, July, and August), and in the Southern Hemisphere during months 12, 1, and 2 (December, January, and February). Build a frequency chart that indicates the number of maximum temperatures occurred during each month of the year. Make your X-Axis be "Months" and your Y-axis be "Number of Maximum Temperatures", as follows:

Number of Maximum Temper-atures

Month 1, Month 2, etc. → Month 12

12. What month experienced the most maximum temperatures? Think about your data and the discussion of seasons above, and then explain why the fact that this month has the most maximums makes sense. Zoom to the location where you live. Select the "Measure" tab and the compass tool, and then click on the location in which you live, as follows:



Based on the latitude for your location, are you located in the Northern Hemisphere or in the Southern Hemisphere? During which months is it summer in your location (give the months as numbers as was given in the data table)? Does it make sense that it is hottest during those months given what you know about the hemisphere you live in?

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13. Open the data table for the minimum temperatures and sort on Rank. Describe what you think "Rank" means.

14. On what continent were the three lowest temperatures ever recorded on the planet?	
15. Sort the table on Latitude. Remember that the Equator is located at 0 degrees latitude. Find the record in the data table that is located closest to the Equator. What is the location of this record? Zoom to this location on the map. Even though this point is closer to the Equator than any other, why does it make sense that it recorded such a low temperature?	

16. Browse through the maximum and minimum data tables and the map. Did any country experience both a maximum extreme temperature and an extreme minimum temperature? If so, which country(s) were they? Change the basemap to topography if you need to, in order to help you better understand the location of each extreme temperature. Explain how these countries could experience both a maximum and a minimum extreme.	

17. Turn on the "Maximum Temperatures from Summer 2010 heat wave" map layer. This layer shows record maximum temperatures from the heat wave. Let's explore how extensive this heat wave was. Use the arrow to the right of the layer name and "Zoom to" that layer to find out. Across which 2 continents did this heat wave extend? What point would you consider to be an "outlier" or "far beyond" the clustering of the other points? Name its location. What is the frequency of maximum temperature occurrence on the Arabian Peninsula (including Saudi Arabia, Kuwait, Qatar, UAE, Oman, and Yemen)?	

18. Show the data table for this heat wave. How many readings are in the data table? What is the **average maximum temperature** for the heat wave? Show your work.	

19. How many days elapsed between the first maximum temperature recorded and the last maximum temperature recorded? In other words, how long did the heat wave last?	

20. Reflect on what you have learned about mathematics and working with web-based GIS in this investigation. What do you feel is the most significant thing you have learned from this lesson?	

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Answer Key. Answers in blue.

1. Think about the hottest day you have ever experienced. Where were you located on this day? What did you do to try to cool off? **Answers will vary depending on the student.**

2. Estimate the temperature on that hot day and indicate it here: _____. What is the difference between the temperature that day and the maximum temperature shown on this map? Show your work.
Answers will vary depending on the student, but make sure they are subtracting correctly from the maximum of 56.70 degrees: If their answer was 40 degrees, the answer should be: 56.70 – 40 = 16.70.

3. Now think about the coldest day you have ever experienced. Where were you located on this day? What did you do to try to warm up? **Answers will vary depending on the student.**

4. Estimate the temperature on that cold day and indicate it here: _____. What is the difference between the temperature that day and the minimum temperature shown on this map? Show your work.
Answers will vary depending on the student, but make sure they are subtracting correctly from the minimum of -89.20 degrees: If their answer was -10 degrees, the answer should be: -89.20 – (10) = 79.20.

5. Examine the pattern of maximum and minimum temperatures on your map. Click on locations to discover more information about them. Name 2 factors that you think influences the climate in a particular location.
Answers could vary, but look for thoughtful responses. Answers could include: Proximity to oceans have an effect on temperature, usually a moderating one, so extremes should not be located on coastlines for the most part. Latitude has an effect: Places closer to the poles should be colder, places closer to the Equator should be warmer. Altitude or elevation has an effect: Higher elevations tend to be colder. Long term climate and daily weather and wind patterns have a role as well.

6. What is the difference between the maximum temperature shown on this map that the planet has ever experienced and the minimum temperature that the planet has ever experienced? **The difference is 56.70 –(-89.20) = 145.9 degrees.**

7. What is the **range** of maximum temperatures shown on this map (between the lowest maximum and the highest maximum)? How many times hotter is the highest maximum temperature than the lowest maximum temperature? Round your final answer to the nearest degree. Show your work. **The range of maximums is 56.70 to 47.40, or 56.70-47.40 = 9.30 degrees → rounded to the nearest degree = 9 degrees.**

8. How many fields exist in the data table? By which field is the table sorted? **There are 8 fields in the data table (there are actually more fields in the data table than 8, but only 8 are made visible. We would not expect the students to know that, so the correct answer is 8.**

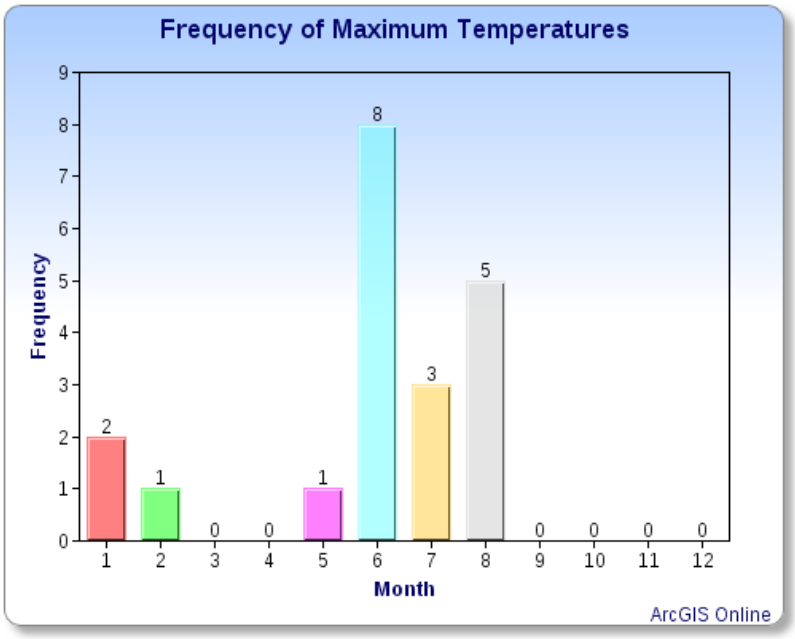
9. Change the sorting of this table by clicking on the column heading "Year" and sorting in ascending order. What is the total range of years represented by this table of data? **1913 to 2011. 2011 – 1913 = 98 years.**

10. How many years ago did the all-time maximum temperature occur on the Earth? Select it in the table. You should see its symbology change on the map as well. Zoom to it on the map. Click on the continent in which it is located. In what continent is it located? In what country is it located? **In 1913. North America. USA.**

11. Sort the table in Ascending order on Latitude. Are extreme hot temperatures more common in the Northern Hemisphere or in the Southern Hemisphere? Examine the location of the hot temperatures and name a reason why so many hot temperatures occur in that hemisphere. Name the location of the hot temperature that is closest to

any pole (either North Pole or South Pole). **Extreme hot temperatures are more common in the Northern Hemisphere, based on the data set here. Reasons: Answers will vary but look for reflections about the larger land masses and deserts (Gobi, Sahara, Arabian) in the Northern Hemisphere. The location of the hot temperature that is closest to any pole is Rank 17: 49.70 degrees at Ading Lake, Turpan, Xinjiang, China, at 42.98 degrees North Latitude. This is in the arid part of northwest China.**

Frequency Chart:



12. What month experienced the most maximum temperatures? **6, or June.** Think about your data and the discussion of seasons above, and then explain why the fact that this month has the most maximums makes sense. **June is a summer month and therefore it makes sense that most of the maximums occur then. A few maximums occurred in January and February when the Southern Hemisphere is experiencing summer.** Zoom to the location where you live. Select the "Measure" tab and the compass tool, and then click on the location in which you live, as follows. Based on the latitude for your location, are you located in the Northern Hemisphere or in the Southern Hemisphere? **Answers will vary. For example, if the students are in the USA, China, Europe, India, or the UAE, they will be in the Northern Hemisphere. The measurement tool will indicate a positive latitude for anywhere in these countries, and negative for countries south of the Equator such as New Zealand and South Africa.** During which months is it summer in your location (give the months as numbers as was given in the data table)? **6, 7, and 8. (June, July, and August).** Does it make sense that it is hottest during those months given what you know about the hemisphere you live in? **Answers will vary slightly but students should indicate that if they are in the Northern Hemisphere, it makes sense that the hottest month—summer—occur in June, July, and August.**

13. Open the data table for the minimum temperatures and sort on Rank. Describe what you think "Rank" means. **Rank means the "order" based on temperature: A rank of 1 indicates the coldest temperature.**

14. On what continent were the three lowest temperatures ever recorded on the planet? **Antarctica. (Makes sense!).**

15. Sort the table on Latitude. Remember that the Equator is located at 0 degrees latitude. Find the record in the data table that is located closest to the Equator. What is the location of this record? Zoom to this location on

the map. Even though this point is closer to the Equator than any other, why does it make sense that it recorded such a low temperature? **The coldest temperature closest to the Equator in the data table is at 27.99 North Latitude. It is in Nepal. Yes, it makes sense that it was so cold because it was at Mt Everest. Higher altitudes and mountains tend to be colder.**

16. Browse through the maximum and minimum data tables and the map. Did any country experience both a maximum extreme temperature and an extreme minimum temperature? If so, which country(s) were they? Change the basemap to topography if you need to, in order to help you better understand the location of each extreme temperature. Explain how these countries could experience both a maximum and a minimum extreme.
According to the map, China, Turkey, and the USA all experienced a maximum and a minimum temperature extreme. Each of these countries is fairly large and contains a wide variety of ecoregions and climate zones, as well as mountains.

17. Turn on the "Maximum Temperatures from Summer 2010 heat wave" map layer. This layer shows record maximum temperatures from the heat wave. Let's explore how extensive this heat wave was. Use the arrow to the right of the layer name and "Zoom to" that layer to find out. Across which 2 continents did this heat wave extend? **Asia and Africa.** What point would you consider to be an "outlier" or "far beyond" the clustering of the other points? Name its location. **Belogorsk, Russia, with a temperature of 42.30.** What is the frequency of maximum temperature occurrence on the Arabian Peninsula (including Saudi Arabia, Kuwait, Qatar, UAE, Oman, and Yemen)? **The frequency was 5. (a 6th point was nearby but it is in Iraq and not on the Arabian Peninsula as specified in this list of countries).**

18. Show the data table for this heat wave. How many readings are in the data table? **10.** What is the **average maximum temperature** for the heat wave? Show your work. **There are 10 readings in the data table. The sum of the maximum temperatures is 52.6 + 52 + 52 + 51 + 49.6 + 48.8 + 47.6 + 47.1 + 46.9 + 42.3 = 489.9 / 10 = 48.99 degrees.**

19. How many days elapsed between the first maximum temperature recorded and the last maximum temperature recorded? In other words, how long did the heat wave last? **The data in this table cover the period from month 6 day 14 to month 7 day 9. In other words, from 14 June 2010 to 9 July 2010. There were 17 days in June covered (June has 30 days), plus 9 days in July; Therefore: 17 + 9 = 26 days total.**

20. Reflect on what you have learned about mathematics and working with web-based GIS in this investigation. What do you feel is the most significant thing you have learned from this lesson? **Answers will vary because the students are asked to reflect upon their learning, but look for thoughtful reflections related to mathematics skills such as rounding, subtraction, averages, ranges, or technical skills, or learning about the relationship between temperature extremes and where they occur around the world in terms of time of the year, altitude, latitude, or another factor.**

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ASSESSMENT CRITERIA: INVESTIGATIONS

Skill	Criteria	4	3	2	1	0
Inquiring **Experimenting**	**Following Instructions**	- Follows almost all instructions in the task accurately	- Follows most instructions in the task accurately	- Follows some instructions in the task accurately	- Follows few instructions in the task accurately	- Follows no instructions in the task accurately
Handling **Researching**	**Organising information/ data**	- Organises all information accurately - Includes all necessary features	- Organises most information accurately - Includes most necessary features	- Organises some information accurately - Includes some necessary features	- Organises little information accurately - Includes few necessary features	- Organises no information accurately
Understanding **Analysing**	**Explaining**	- Gives complete and accurate descriptions and reasons for results	- Gives complete and accurate descriptions and partly complete and accurate reasons for results	- Gives complete and accurate descriptions	- Gives partly complete and accurate descriptions **OR** - Repeats mathematical terms for results	- Gives no accurate descriptions
Evaluating **Reflecting**	**Making informed judgements/ decisions**	- Forms an opinion that is supported entirely by the evidence available	- Forms an opinion that is supported mostly by the evidence available	- Forms an opinion that uses some evidence	- Forms an opinion	- Forms no opinion
Participating ***(Choose the appropriate criterion)***	**Collaborating with other students**	- Contributes fully to the group's work - Understands the group's results completely	- Contributes fully to the group's work - Understands most of the group's results	- Contributes partly to the group's work - Understands some of the group's results	- Contributes little to the group's work - Understands little of the group's results	- Makes no contribution
	Working independently and persevering	- Requires almost no supervision or encouragement - Tries to complete almost all task activities	- Requires some supervision or encouragement - Tries to complete most task activities	- Requires regular supervision or encouragement - Tries to complete some task activities	- Requires frequent supervision or encouragement - Tries to complete few task activities **OR** - Seeks immediate help	- Requires constant supervision to complete any task activities
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معيار التقويم: التحقق

المهارة	المعيار	4	3	2	1	0
الاستفسار	**اتباع التعليمات**	- يَتبع غالبا جميع التعليمات المذكورة في المهمة بدقة.	- يَتبع معظم التعليمات المذكورة في المهمة بدقة	- يَتبع بعض التعليمات المذكورة في المهمة بدقة.	- يَتبع القليل من التعليمات المذكورة في المهمة بدقة.	- لا يَتبع أيًا من التعليمات المذكورة في المهمة بدقة.
طرق المعالجة	**تنظيم المعلومات/البيانات**	- يُنظم جميع المعلومات بدقة. - يُضمَن جميع المميزات والخصائص الضرورية.	- يُنظم معظم المعلومات بدقة - يُضمَن معظم المميزات والخصائص الضرورية.	- يُنظم بعض المعلومات بدقة. - يُضمَن بعض المميزات والخصائص الضرورية.	- ينظم القليل من المعلومات بدقة. - يُضمَن القليل من المميزات والخصائص الضرورية.	- لا ينظم أيًا من المعلومات بدقة.
الفهم	**التوضيح**	- يُعطي وصفا كاملا ودقيقا وأسبابا للنتائج.	- يُعطي وصفا كاملا ودقيقا وأسبابا دقيقة جزئيا للنتائج.	- يُعطي وصفا دقيقا وكاملا.	- يُعطي وصفا دقيقًا جزئيا وغير كامل. **أو** - يكرر التعابير الرياضية للنتائج.	- لا يعطي أي وصف دقيق.
التقييم	**صنع تشكيل الأحكام/القرارات**	- يُشكل رأيا مدعما كليا بالدليل المتوفر.	- يُشكل رأيا مدعما على الأغلب بالدليل المتوفر.	- يُشكل رأيا مستخدما بعض الأدلة.	- يُشكل رأيا.	- لا يشكل رأيًا.
التعمق ونقل الخبرة	**التعاون مع الطلاب الآخرين**	- يُشارك مشاركة كاملة بعمل المجموعة ويفهم نتائج المجموعة بشكل كامل.	- يشارك مشاركة كاملة بعمل المجموعة ويفهم معظم نتائج المجموعة.	- يشارك مشاركة جزئية بعمل المجموعة ويفهم بعض نتائج المجموعة.	- يشارك بصورة قليلة بعمل المجموعة . - يفهم القليل من نتائج المجموعة.	- لا يقوم بأية مشاركة.
المشاركة	**العمل بالاعتماد على النفس والمواظبة**	- لا يحتاج في الغالب لأي إشراف أو تشجيع. - يُحاول غالبا إكمال جميع أنشطة المهمة.	- يحتاج بعض الإشراف أو التشجيع. - يُحاول أن يكمل معظم أنشطة المهمة.	- يحتاج دعمًا أو تشجيعًا دوريًا لإكمال بعض أنشطة المهمة. - يُحاول إكمال بعض أنشطة المهمة.	- يحتاج إلى دعم أو تشجيع متكرر. - يُحاول إكمال القليل من أنشطة المهمة. **أو** - يبحث عن مساعدة فورية.	- يحتاج إشرافًا دائمًا لإكمال أي من أنشطة المهمة.
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(اختر المعيار المناسب)