Misconception Assignment:
“Mass and Weight are not Equivalent?”

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Identification and Description of Misconception:
An application of predict, explain, observation, and explain (PEOE) model used by Dial (2009) will be used to reinforce the concept of mass vs weight. Students will be broken into pairs to talk about the following series of questions to identify whether they have a misconception about mass and weight:

1. Is there a difference between mass and weight? If so, explain why?
2. What is the standard unit to measure mass? Is it the same as weight?
3. If you were walking on the moon, would your mass change? Would your weight change?

Teacher Only* *The teacher will walk around the classroom and listen to the conversations that students are having. Based on the conversations the teacher will assess whether the students have a misconception about whether mass and weight are synonymous or not. If students are explaining that there is no difference between the mass and weight, your mass and weight are both measured in kg, or predict that your mass changes on the moon, then you have identified that there are misconceptions about mass and weight present in your class.*

A common misconception that students in grade 6 could make is believing that *mass and weight* mean the same thing. This misconception can be addressed using the *6-4-11* learning outcome, where mass and weight are given clear distinctions. To address this misconception, my class will talk about how gravitational acceleration differs on Earth. Students will establish that gravitational acceleration on Earth is not constant using altitude. We can consider the force of gravity based on the gravitational acceleration function and explain how it correlates. From this conclusion, it is easier to explain that gravitational acceleration based on other planets is not constant. Hence, the force of gravity varies on other planets.

6-4-11	Recognize that mass is the amount of matter in an object, that weight is the force of gravity on the mass of an object, and that the force of gravity varies from planet to planet.	GLO: D3

Why is it Problematic?
Mass and weight are often interchangeably used on Earth. By hearing that these words are interchangeably used they may associate that they have equivalent meanings. For example, students may hear at the doctor's office that they weigh a certain amount, typically measured in kg. They may also hear that they have ‘x’ amount of mass, additionally measured in kg. However, what they are hearing in a public space is a misconception about mass and weight. By associating the two terms, students may believe that weight is a constant value. Using mass and weight interchangeably can lead to incorrect interpretations of formulas. This can be detrimental in aviation where airplanes use their weight to calculate fuel requirements based on flight altitudes. By flying at higher altitudes, the weight of the plane will be lower, and can reduce fuel consumption. If you fly a plane at a reduced altitude, you may run out of fuel before reaching your destination. When this occurs, it may result in casualties.

Correct Scientific Explanation:
Mass is the amount of matter that makes up an entity. For example, a human's mass is the amount of matter that is in their body. *Weight* (W) essentially constitutes the force (F_g) exerted on matter by the gravitational attraction (Britannica, 2025). In this case, weight is the force that your body experiences from gravitational attraction to the Earth. The gravitational force that your body experience is given by the following formula:

$$W = F_g = mg$$

Addressing the Misconception:
Teacher Only* *Students will use a free graphing calculator resource (DESMOS, 2025) to construct graphs and display gravitational acceleration. Students will observe, interpret and evaluate how changes in the function variables impact gravitational acceleration. Students will observationally compare how changing altitude, the mass of the Earth, and the radius of the Earth impacts gravitational acceleration. Using a graphing calculator satisfies 6-0-6A (cluster 0) learning outcome.*

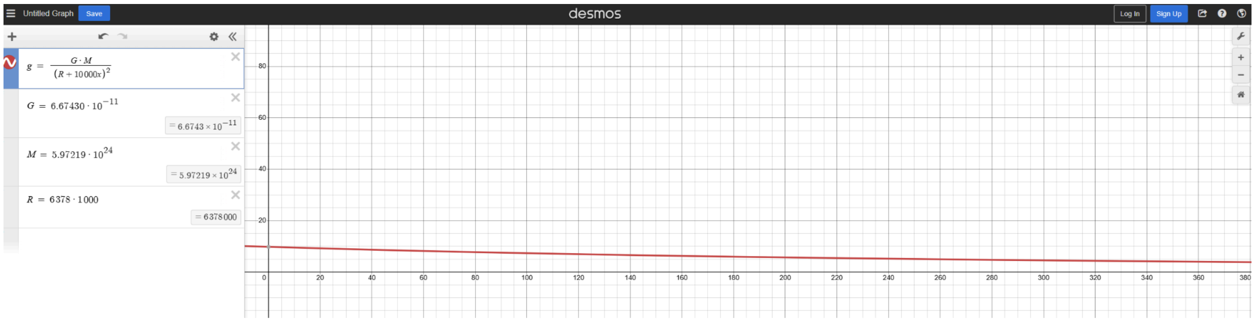
6-0-6A	*Construct graphs to display data and interpret and evaluate these and other graphs.* *Examples: frequency tallies, histograms, double-bar graphs, stem-and-leaf plots*	*GLO: C2, C6*

An exception to this occurring at high altitudes, where there is a reduced gravitational force acting on the plane. In this case, the mass of the plane does not change but their weight will decrease. Weight is calculated based on the object's mass and gravitational force. Gravitational acceleration is dependent on the altitude above sea level, given by the following formula (Deng, 2008):

$$g = \frac{GM_e}{(R_e + Z)^2}$$

Using this relationship, we can plot the inverse graph of altitude (Z) vs gravitational acceleration (g). Where G is the universal gravitational constant, M_e is the mass of the Earth, and R_e is the radius of the Earth. Based on gravitational acceleration function, as altitude increases, the plane will experience a reduced gravitational acceleration.

Students will be able to visualize the difference in gravitational acceleration when a variable changes using DESMOS. For example, the following figure describes the decrease in gravitational acceleration based on the scaling of altitude. *Students are not expected to create the function to input any of the information* into the website but are expected to use the *variable slider* given on the left-hand side to see what happens when you change one of the values for questions 1-6. *Students* will be able to use the cursor in DESMOS to look up points on the graph or get the value by typing in the values listed in the tables to get results to answer the following questions.



Desmos application of altitude variation of gravitational acceleration (DESMOS, 2025).

Once students have grasped an understanding that gravitational acceleration is dependent on the proximity between objects, we can now look at the differences between those objects. To address this, the class may consider what may occur when we alter one of the variables of the gravitational acceleration function. For example, we can use DESMOS to visualize the difference in gravitational acceleration when adjusting the mass of the planet. Corollary, we can visualize the difference in gravitational acceleration when adjusting the radius of the planet.

Teacher Only* *By the end of the lesson, students should be able to fill in the table, and explain the following information after having time allotted to using the graphing calculator:*

gravitational acceleration (g)	altitude (Z)
	0 m
	1,000 m
	1,000,000 m
	1,000,000,000 m

1. What is the gravitational acceleration (g) when your altitude (Z) is 0?

2. What happens to the gravitational acceleration (g) when your altitude (Z) increases? Does it increase or decrease?

A second graph will be given to the students to answer the following questions with altitude set to zero *(i.e. removed from the previous equation to simplify, a slider can be used between 0.1 and 100 to evaluate the mass or radius respectively to record the new g value)*:

$$g = \frac{GM_e}{R_e^{\,2}}$$

gravitational acceleration (g)	Planet Mass (M_x)
	0.1 M_e
	1 M_e
	10 M_e
	100 M_e

3. What happens to the gravitational acceleration (g) when your planet mass (M_x) increases? Does it increase or decrease?

4. What happens to the gravitational acceleration (g) when your planet mass (M_x) decreases? Does it increase or decrease?

gravitational acceleration (g)	Planet Radius (R_x)
	0.1 R_e
	1 R_e
	10 R_e
	100 R_e

5. What happens to the gravitational acceleration (g) when your planet radius (R_x) increases? Does it increase or decrease?

6. What happens to the gravitational acceleration (g) when your planet radius (R_x) decreases? Does it increase or decrease?

summary:

Teacher Only* *In conclusion, we have discerned the differences between mass and weight. We have touched upon how confusing mass and weight could cause an aviation incident. We have provided a correct scientific explanation of the differences between mass and weight. Lastly, we have addressed the misconception while incorporating a cluster 0 learning outcome.*

Bibliography:

Britannica, T. Editors of Encyclopaedia (2025, January 18). *mass*. *Encyclopedia Britannica*. https://www.britannica.com/science/mass-physics

Deng, Y., Ridley, A. J., & Wang, W. (2008). Effect of the altitudinal variation of the gravitational acceleration on the thermosphere simulation. *Journal of Geophysical Research: Space Physics*, *113*(9). https://doi.org/10.1029/2008JA013081

Desmos: Graphing Calculator (2025). https://www.desmos.com/calculator

Katrina Dial, D. R. K. W. and V. S. (2009). *Addressing Misconceptions*. https://brandonuniversity-my.sharepoint.com/personal/watsone_brandonu_ca/_layouts/15/onedrive.aspx?id=%2Fpersonal%2Fwatsone%5Fbrandonu%5Fca%2FDocuments%2FTeaching%2FScience%20Ed%20Courses%2FOld%20Courses%20%26%20Resources%2F2022%2E%20Wi%2E%20Science%20MY%2FWeek%203%20%2D%20Conceptual%20Understanding%2FArticles%2FAddressing%20Misconceptions%2Epdf&parent=%2Fpersonal%2Fwatsone%5Fbrandonu%5Fca%2FDocuments%2FTeaching%2FScience%20Ed%20Courses%2FOld%20Courses%20%26%20Resources%2F2022%2E%20Wi%2E%20Science%20MY%2FWeek%203%20%2D%20Conceptual%20Understanding%2FArticles&ga=1