

## Lesson Adaptation Activity: Constructing Explanations

### Related MA STE Framework Standard:

**MS-LS1-5.** Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms. *[Clarification Statement: Examples of local environmental conditions could include availability of food, light, space, and water. Examples of genetic factors could include large breed cattle and species of grass affecting growth of organisms. Examples of evidence could include drought decreasing plant growth, fertilizer increasing plant growth, different varieties of plant seeds growing at different rates in different conditions, and fish growing larger in large ponds than they do in small ponds.] [Assessment Boundary: Assessment does not include genetic mechanisms, gene regulation, or biochemical processes.]*

### Lesson Description & Introduction

*Ms. Kim's 8<sup>th</sup> grade class is in the middle of a unit on Growth, Development, and Reproduction of Organisms. In this particular lesson, students are using the data involving the growth of rice plants in various environmental conditions to construct a scientific explanation of how environmental factors can influence the growth of organisms. Students will use the evidence from the data they analyzed and their scientific understanding of growth and development to construct their explanations. In the next class, students will compare the genetic factors that influence the growth and development of the rice plant with another species of plant.*

**Ms. Kim:** Good morning, class. So yesterday we analyzed the growth data of several seedling rice plants placed under different environmental conditions for two weeks. Can someone remind me what those conditions were? Call them out!

**Craig:** One of the rice plants was exposed to a drought condition. *[Reads from worksheet]* It did not receive any water for 5 days straight. Then it was watered for two days. Then this cycle was repeated another time.

**Anne:** Another plant was kept at 40 degrees Fahrenheit for two weeks.

**Sam:** There was also a rice plant exposed to a heat condition. *[Reads from worksheet]* The plant was placed under grow lights at temperature of 90 degrees for two weeks.

**Mike:** The last condition was the light one. The plant was exposed to light for 24 hours a day for the whole two weeks.

**Ms. Kim:** Great! Thank you to everyone who shared. Now there was also a control condition. What was that condition for?

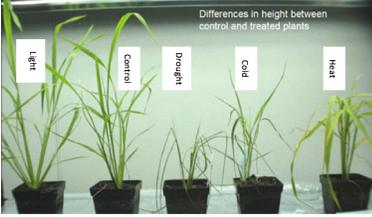
**Becky:** The control condition was to see how the rice plant grew under normal temperature, water, light, and soil conditions. It was used to compare to the other conditions, where we changed only one variable in each condition group.

**Ms. Kim:** That's right. Now I want you to look at our data table from yesterday. The investigator measured growth in a number of ways. Can someone look at the data table and remind me?

**Olga:** They measured plant height, the number of leaves, and the root length.

**Ms. Kim:** Great. Now yesterday with your groups you analyzed the data for trends. Today you are going to discuss and interpret those trends with your groups. After you finish discussing the findings, you will construct a scientific explanation for the question: How did the environmental factors in the experiment influenced rice plant growth? Any questions? *[pauses]* Okay then, each group please come pick up a worksheet, and then you can move back into your groups and we can get started!

Treatment	Plant Height (cm)	Number of Leaves	Root Length (cm)
Drought	26 cm	6	3 cm
Heat	41 cm	14	8 cm
Cold	45 cm	8	7 cm
Light	80 cm	27	22 cm
Control	75 cm	24	19 cm



## Lesson Adaptation A

*Ms. Kim circulates around the classroom and listens in on one group as they discuss the plant growth data and begin to construct their scientific explanation.*

**Craig:** So it looks like the light condition and the control condition plants grew the biggest at 61 cm and 58 cm. They also had more leaves and longer roots compared to the other conditions.

**James:** Yeah it looks like the other conditions had much shorter rice plants.

**Ms. Kim:** Why do you think you saw this pattern?

**Andrea:** Well plants need water so the drought condition would hurt the plant. Also we learned from our research [*reads from worksheet*] that the plant grows best at a temperature between 68 and 80 degrees Fahrenheit, so the heat and cold conditions would also hurt the plant.

**Ms. Kim:** You are right, and why do they need watering and the right temperature to grow best? Think about what we have learned about plants and what materials they need to grow.

**Craig:** Well I know that plants need food to grow. And that plants make their own food by photosynthesis.

**Ms. Kim:** That's right. Now how might the process of photosynthesis be affected by these different conditions? Think about what you know about photosynthesis and chemical reactions. *Ms. Kim leaves the group and continues to circulate the classroom.*

**James:** Well, plants use water in photosynthesis to make food. So if there was less water there would be less food.

**Andrea:** And if there is less food the plant won't grow a lot!

**James:** Yeah. And the opposite for the light condition. Light is needed for photosynthesis. More light means more food and more growth.

**Craig:** But what about the heat and cold conditions. How do they affect photosynthesis?

**Andrea:** I remember Ms. Kim talking about enzymes the other day. Maybe they are involved. Let's ask Ms. Kim [*raises hand*] Ms. Kim, we are thinking about why the heat and cold conditions didn't grow as much as the control plant. We think it might be because of enzymes.

**Ms. Kim:** That's an interesting idea! Can someone remind what enzymes do?

**Katie:** [*Looks back at notes*] They help to speed up chemical reactions.

**Ms. Kim:** That's right. So how could enzymes be involved in the process of photosynthesis and how could they be affected by the heat and cold? *Ms. Kim leaves the group and continues to circulate the classroom.*

**James:** Well photosynthesis is a chemical reaction so enzymes are probably involved. And it says here that [*Reads from notes*] temperature can decrease enzyme activity.

**Andrea:** So maybe the heat and cold conditions decreased enzyme activity. We should start writing now, I can write for us.

**Ms. Kim:** *Ms. Kim calls the attention of the class.* So I see that several groups are beginning to write their explanation. Please remember to discuss the three key features of a scientific explanation. You need an explanatory account which describes how or why a phenomenon occurs, the science ideas that apply to make sense of a specific phenomenon and the evidence in the form of scientific data such as measurements and observations that support your explanation. Also please make sure to write your explanation response on the worksheet I have provided. I will collect each groups' worksheet at the end of class.

**Katie:** First thing we need to do is give an explanatory account. Write that the drought, heat, and cold conditions caused the rice plant to grow shorter than the control plant and that the light condition caused the rice plant to grow taller than the control plant.

**Craig:** Okay. Now we need the science ideas that back up our explanation. We need to talk about photosynthesis. Andrea, write down that plants use water in photosynthesis to make food. So if there was less water there would be less food for the plant. And less food means less growth.

**Andrea:** I think we also have to talk about enzymes. I am going to write that the temperature was too hot or too cold for enzymes to work.

**James:** We also need to say that enzymes are used in photosynthesis. So if the enzymes don't work, photosynthesis won't work either.

**Andrea:** Yeah you are right, I'm gonna write that down. Now all we need is the evidence. I think we just need to include data from the table that shows that the drought, heat, and cold condition plants were shorter than the control plant.

## Lesson Adaptation B

*Ms. Kim circulates around the classroom and listens in on one group as they discuss the plant growth data and begin to construct their scientific explanation.*

**Andrea:** It looks like the drought, cold, and heat condition plants are all kind of short.

**James:** Yeah and it looks like light and control condition plants are tall.

**Ms. Kim:** Okay, so let's think about each condition then. What does the data tell you about the drought condition? Focus on the plant height for now. You can talk about the other types of data when you write up your explanation.

**Katie:** Well, without water the plant had a height of only 26 cm compared to 75 cm in the control plant. So that tells me that plants need water to grow tall.

**Ms. Kim:** Okay and what about the heat and cold conditions? What do you see in the height data there?

**Craig:** The cold condition plant had a height of 45 cm and the heat condition plant had a height of 41 cm. Both of these heights were shorter than the control plant.

**Katie:** That tells me that the environment was too hot or cold for the plant to grow good.

**Ms. Kim:** That's right. Now do the same for the light condition? *Ms. Kim leaves the group and continues to circulate the room.*

**James:** The light seemed to help plant growth. It grew 5 cm taller than the control plant.

**Katie:** Yeah. So according the data, the heat, cold, and drought environmental factors hurt the plants growth and the light condition helped the plants growth.

**James:** Alright, so we should write our explanation now.

**Ms. Kim:** *Ms. Kim calls the attention of the class.* So I see that several groups are beginning to write their explanation. Please remember that you should use the rice plant data as evidence to support your explanations. Also remember to write your explanation response on the worksheet I have provided. I will collect each groups' worksheet at the end of class.

**Craig:** Okay, so I will write for us. So we have to answer the question: how did the environmental factors in the experiment influence rice plant growth?

**Andrea:** Well, the light condition increased rice plant growth and the drought, heat, and cold conditions decreased rice plant growth.

**Katie:** Yeah. Now we need to include evidence. We need to show how the data from the table that supports our explanation.

**Andrea:** Craig, write down that the drought, cold, and heat plants were shorter, had fewer leaves, and had smaller roots than the control.

**James:** We need to include the actual data also. So write down the actual plant heights, number of leaves, and root lengths for each conditions

**Craig:** Okay, so after I copy down the data from each of the conditions, then what should I write?

**James:** Then we have to show that the actual measurements for height, number of leaves, and root length for the drought, heat, and cold conditions are smaller than for the normal control plant. So we can conclude that those conditions hurt the growth of the plant.

**Katie:** Also we need to say that the light condition was taller, had more leaves, and longer roots compared to the control. So light helped the plant grow taller.

**Craig:** [*writes*] Okay I think I got it all. We have talked about all the environmental factors from the experiment. Let's just read it over before we hand it in.

## Lesson Adaptation C

**Ms. Kim:** Now before you and your group members construct your explanations, let's first discuss the data. We noticed yesterday that the drought, cold, and heat condition plants grew shorter than the control plant and that the light condition plant grew larger than the control plant. So I am going to write these trends on the board [*writes trends on the board under heading: explanatory account*] So now let's think about why the drought, cold, and heat condition plants were shorter than the control plant? Let's start by thinking about the rice plant's food. We know all plants need food to grow. How do plants get their food?

**Katie:** By photosynthesis.

**Ms. Kim:** That's right. And we know that photosynthesis is a chemical reaction. Who remembers the reactants and products of this reaction?

**Craig:** Carbon dioxide, water, and sunlight come together to make glucose and oxygen.

**Ms. Kim:** Good! Now it seems that the drought condition would disrupt this reaction because with less water, photosynthesis couldn't occur as much. And if the rate of photosynthesis slows down then less food will be made and the plant will grow less. I am going to write that on the board under science ideas [*writes on the board*]. Does that make sense?

**Olga:** That makes sense, but why does the temperature affect rice plant growth? Temperature is not part of photosynthesis.

**Katie:** Yeah, I'm confused about that too.

**Ms. Kim:** That's a great question. To answer it, we need to think about our research on rice plants and our knowledge of enzymes. Who can remind me what an enzyme does?

**Andrea:** An enzyme is a protein that can speed up chemical reactions. I also remember that there is an enzyme used in photosynthesis to help make glucose.

**Ms. Kim:** Great memory, and can someone remind me what temperature rice plants grow at?

**Becky:** The rice plant grows best at 68 and 80 degrees Fahrenheit.

**Ms. Kim:** Okay. So now if we think back to our lesson on enzymes, you will remember that enzyme activity can be affected by temperature. It seems that the enzymes in this plant must work best at a temperature between 68 and 80 degrees Fahrenheit because that is the temperature the plant grows best at. The heat and cold conditions are not between those temperatures so I think those conditions will negatively affect enzyme activity. With less enzyme activity, there will be less photosynthesis and less food. And with less food there will be less growth. I am going to write this also under science ideas [*writes on the board*].

**James:** What about the light condition?

**Ms. Kim:** Well, in the light condition there is more light energy for photosynthesis, so the rate of photosynthesis can increase. More photosynthesis, more food, more food, more plant growth. That make sense? [*Writes on the board*]

**James:** Kind of. But why didn't it grow a lot bigger than the control then.

**Ms. Kim:** Good question. Think back to when we talked about the genetics of the rice plant in our research. Different plant species grow to different typical sizes based on internal factors involving their genes. How big should a normal plant be at day 75?

**Anne:** The rice plant should be about 70-75 cm.

**Ms. Kim:** That's right. So the rice plant's genes will generally determine the average size and how big it can get. So the rice plant can get bigger than normal due to the environmental factor but not too much bigger due to its genetics. [*writes on the board under science ideas*] Now we have to talk about evidence for our explanation. We need specific data that backs up our explanation. Let's look at the data from the table again and let's focus on plant height. Can someone list off the plant heights for me?

**Becky:** The drought plant was 26 cm, the heat plant was 41 cm, the cold plant was 45 cm, the light plant was 80 cm, and the control plant was 75 cm.

**Ms. Kim:** Good. So I think we should compare the plant heights of the experimental conditions to the control condition to support our explanation. I am going to write what we see on the board [*Writes heading: Evidence, then writes: drought (26 cm), heat (41 cm), and cold conditions (45 cm) are shorter in height than the control condition (75 cm). Light condition (80 cm) is taller in height than the control condition (75 cm)*] So I now I want you to to write your scientific explanation with your group members. Please remember to discuss the three key features of an explanation as I have done on the board. I will collect each groups' worksheet at the end of class.

## Lesson Adaptation D

*Ms. Kim circulates around the classroom and listens in on one group as they discuss the plant growth data and begin to construct their scientific explanation.*

**Ms. Kim:** What trends did you see in the data?

**Andrea:** The light condition plant was taller than the control group plant.

**James:** Yeah, and the drought, cold, and heat condition plants were shorter than the control plant.

**Ms. Kim:** Why do you think this happened?

**Katie:** Plants need to be watered and kept at the right temperature to live and grow.

**Andrea:** Also we learned from our research that the plant grows best at a temperature between 68 and 80 degrees Fahrenheit. The heat and cold conditions are not between those temperatures, so it won't grow well.

**James:** So now we should write our explanation. I will write for us. So how did the environmental factors in the experiment influence rice plant growth? We know the plant doesn't grow well when it is too hot or too cold or when it gets too little water.

**Craig:** Yeah, write that the drought, heat, and cold conditions decreased rice plant growth.

**Ms. Kim:** Make sure to include information about how the conditions are shorter *compared to the control condition*. That is important!

**Craig:** Oh yeah. So then write the light condition increased rice plant growth compared to the control plant and that the drought, heat, and cold conditions decreased rice plant growth compared to the control plant.

**Ms. Kim:** Good!

*Ms. Kim leaves the group and continues to circulate the classroom.*

**Katie:** What about for the light condition?

**Craig:** We need to write that the light condition increased rice plant growth compared to the control group plant.

**Ms. Kim:** *Ms. Kim calls the attention of the class.* So I see that several groups are finishing their explanations. Please remember to describe all relevant findings from the data in your explanation.

**James:** I think we are good! We have talked about the environmental factors in the experiment. Do we need anything else?

**Andrea:** Let's just read over before we hand it in!

## Ordering of Adaptations

**Directions:** Order the four adaptations (A-D) along the Science Practice Continuum (Levels 1-4) for the Constructing Explanations practice.

	Level 1	Level 2	Level 3	Level 4
Adaptations				