Using Formative Assessment to Help Guide Student Understanding of Climate Change

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Abstract

Throughout this paper we will examine how formative assessment can be a useful tool across all areas of instruction, at every stage of instruction. I will specifically use the example of three stages of instruction, as I introduce the topic, half way through a unit, and at the close of the unit. We will examine how to utilize formative assessment in order to give both instructor and students an idea of strengths, and weaknesses on a particular subject. It will be discussed using the example of climate change, specifically what the main indicators of climate change are, the distinction between climate change and global warming, and the causes of the problem at hand. The learning objective in this unit was for my AP Environmental Science class to not only address climate change but also utilize the topic to review all the themes and units of the year, in preparation for the AP exam. Specific task will be described, examined, synthesized, while student work will be studied and dissected. I will also utilize a potion of this paper to reflect upon my teaching this unit, and posture how I could change it for the better in the future.

Topic Description

When we return from spring break I will begin wrapping up my AP Environmental Science class. We traditionally close the class with Global Climate Change, as it serves as a good review for the AP test they take early May. The main ideas I will be teaching are what climate change really is, how greenhouse gasses cause it, what green house gasses are, what the causes of climate change are, and finally what can be done/human's role in the problem. Students often come with many misconceptions about climate change, especially since I teach it when it is usually still cold out but the calendar says spring! This is a pretty interesting but difficult to teach topic. By this time in the year my students have a pretty good idea about the workings of the environment and that pollution is bad, and preventable, or at least reducible. But there are many misconceptions when it comes to global climate change. Since we have had two fairly extreme winters the past two years students have a hard time accepting the data that our global temperature is on the rise. There is also a lot of misinformation in the media about climate science, often times that is the only knowledge of the subject my students have, or their opinions are not shaped by the science but by their parents and what they see on TV or via the internet. Much of the credible scientific data available on the topic is complex so it is difficult for my students to make sense of it. The challenge is always to wade through the misconceptions, and unpack the hardcore science.

Targeted Learning Goals

The specific goals to be addressed in this chapter/unit as well as through my formative assessment tasks are:

What misconceptions are there about climate change? (Humans are not the cause; we don't have global warming, its been so cold; its just a natural trend of the Earth)

How can we address the misconceptions? (Educating the school community as well as their social circle/family about the facts of global climate change)

Why is the global temperature rising? (Increased greenhouse gasses)

How can we fix it? (Small and large changes both personally and on a large societal scale)

Formative Assessment Task(s)

Before we begin the topic students will be given a handout to fill out (Appendix A). They will fill out the hand out that asks general questions about global climate change. They will complete this handout in class so we can then discuss the assessment in class with one another so students can hear each other's ideas; students will also be asked to have a family member of friend complete this assessment; the assessment will be given again midway through the topic as well as at the close of the topic.

Formative Assessment Task(s) Rationale

I like the idea of giving them the exact same questions three times so I can assess what they are grasping as we go on in the topic. Having them do it at the beginning addresses their misconceptions. I want to know if they know the distinction between global warming and climate change. I am hoping I will be able to understand their misconceptions with the first

handout, and then be able to gear my instruction in order to address those misconceptions. The middle handout I believe is the most important task, I want to know how my students are progressing, if at all. If many of my students have grown a lot by the middle task then I can spend slightly less time on the topic and begin to review for the AP college board test sooner than planned, and if students are not progressing as I would have hoped I can retool the second half of my plans. Finally, I think the last time I give the assessment is designed to let me know if my students are ready for a summative assessment. Furthermore it is designed more so than the other two for my students, my students will be given this shortly before a summative assessment is planned; by looking at their answers and my feedback they will gain a deeper understanding for whether or not they are ready for the summative assessment.

I wanted to include having a friend or family member take the assessment for a few reasons, one is to see if my students talk about our class outside of our class, as well as to encourage them to talk about our class outside of our class, and to encourage others to care for our environment, and enact the small changes we will be learning about in order to combat global warming.

I am hoping by the second time the students are asked to do the assessment most of the misconceptions have been cleared up. By the last time I am hoping that students show me mastery and their readiness for the exam. Please see the scoring guideline attached to Appendix A.

Analysis of Student Work

Assessment 1-

I wasn't sure what to expect on my first task. I knew that my students should have known a fair amount about the topic going in as we have been hinting at it for sometime. Even though we had been talking about global climate change throughout the year we have not yet called it by that name specifically. I was initially disappointed with their responses, as I mentioned I thought the students would do much better on the pre-assessment since they has been exposed to most of the ideas behind global climate change. A few students were almost dead on, explaining accurately the difference between global climate change and global warming, and explaining the reasoning behind it. Some students however gave me responses that led me to believe they hadn't been paying attention at all! I had to keep myself from being too disappointed! This was after all just a pre-assessment. I had almost all of my students correctly tell me that climate change is not the same thing as global warming; just their explanations were off. I knew that this was something we could build on in our first lesson; yes there is a difference, but what exactly is the difference? I was most worried about the misconceptions that I would see; since misconceptions often are unexpected to educators and are extremely hard to correct, especially if tied to personal beliefs. (Dial, K., Riddley, D., Williams, K., Sampson, V. 2008) Once I looked over the family/friend responses it became clear that many of my students who did not have a firm grasp on climate change and global warming, also have a friend or family member that lacked in this knowledge as well; this is either because my students were not talking about the course work as much as they should have been or because the beliefs/ ideas were shared within a family. The most common misconception I saw is that climate change has become a term that simply replaced global warming. I hoped that this would be a misconception I could easily fix. My students listed some great responses as to what is causing

climate change but they were all very general. The only real misconceptions I saw for this particular response were a few students saying things like ‘its all natural’ or ‘the sun is getting hotter’. The biggest issue with the final question (What can we do to help slow/stop climate change?) was that the students’ responses were too general. I was hoping to transform their more general answers such as, use less energy, reduce, reuse, recycle, and use alternative energy into more specific answers. (Gooding and Metz 2011)

Assessment 2-

The second time the students were asked to complete the assessment their answers were a lot more specific! I now saw 100% of my students telling me that there is in fact a difference between climate change and global warming(Appendix B); their explanations also got better but still have not become perfect. My students who did not do well on the first assessment have improved as far as their details are concerned; but they are still the ones who are behind a bit. A few misconceptions I am still seeing are several students telling me that climate change isn’t really due to humans as much as ‘they’ say and that it is a natural cycle. I believe that the reason my students are still holding onto this misconception is the idea that misconceptions are SO hard to change. It is similar to the concept of practicing a musical piece incorrectly several times, it is so very easy to slip back into the habit of playing it incorrectly, even after you learn the correct way to play it. At the point in time that I gave my second assessment we had covered the basic fact that climate change exists, it is different than global warming, and that scientists agree that it is at least in part due to human activity. We had just started to cover the climate science as far as

what exactly proves that we are the cause, and exactly what is contributing to global climate change, as well as what can be done.

Assessment 3-

By the close of the topic we had covered pretty much everything that is required of the AP course. Of course we didn't have time to devote as much study to climate change as we could have (there are people who spend their lives researching the topic). My students should have been well equipped to appropriately answer the formative assessment. I have noticed that, not only are my students' scores improving drastically, but their family/friends' scores are improving as well. My students now 100% know what climate change is and that it is indeed different than global warming, I still have several students who are uncertain as to exactly how they are different but they are able to utilize science in backing up their responses. All of my students are now able to point to several greenhouse gases as well as their sources in the causes of global climate change question. I do have one or two students that are still placing too much responsibility on the natural cycles causing climate change. I am most impressed with my student growth on the last question, what they could now do to help the climate problem. All of my students have listed at least a few very specific things that can be done to help combat the problem. My students did a great job talking about not only large things that can be done, i.e. installing solar panels, or relying more on wind power, but they also focused on small changes they can make in their homes and lives starting today.

Reflections on Teaching

I initially did not think that this project would be as helpful to my teaching practices as it was. I believe that assessments should be altered daily based off of the previous day(s) lessons; student misconceptions and understanding should shape your teaching practices. I tend to think that I do a fairly good job in putting that into practice; however sitting down an applying this assignment to my teaching and planning helped me grow even more as an educator. I feel as though I was able to see thing ordinarily I wouldn't. Most of the time when I am formatively assessing students with the purpose of finding misconceptions I generally verbally assess my kids, or I give a written assessment that I don't every have the time to properly read and assess them. Having this paper to write forced me to actually look at their misconceptions and build lessons not just based on the misconceptions I thought they would have or that most students have but based around the actual misconceptions that appeared. By looking at the same assignment three times I was not only given the opportunity to look at my instruction with a critical eye; building off the students' specific ideas but I was able to also see how well my lessons were being received. If I were to predict what my students would know well and not so well by the halfway point it wouldn't necessarily have been what the formative assessments proved! I was pretty pleased with the feedback I received from the formative assessment; I don't believe there were any parts that went in a different way other than as planned. I know that next year when I go to teach this topic I will not only utilize a similar formative tool but I will also have a better starting point as far as what types of misconceptions my students would have coming into the topic.

Conclusion

All teachers have the responsibility to help build gaps n students' prior knowledge and new ideas in order to really achieve understanding (NRC, 2005) I feel as though formative assessment is the best tool to accomplish this. As an educator I believe one can easily slip into the 'I know best' mentality. It is easy, due to habit and time constraints to just do it the same way its always been done. But truthfully the best way to teach is to assess your students knowledge and their need, before teaching, during teaching, and after. No matter how many years you are in the profession no matter how many years the misconceptions can be the same, there will always be surprises. We never teach the same group of students twice. This assignment more than anything taught me that we need to take our time as educators to truly remember why we went into the profession. We owe it to each and every student to truly determine what they need and deserve from us.

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Appendix A

Climate Change Pre/mid/Post Assessment

Directions: Answer each of the following to the best of your ability using complete sentences. Ask a friend or family member to do the same.

1.) What is global climate change?

2.) Is it the same as global warming? Why or why not?

3.) What is the cause of climate change?

4.) What can we do to help address climate change?

Attachment 1 (assessment given to students three times; students also gave assessment to their friend or family member three times)

Scoring Guideline Pre-Assessment

Students should be given credit for simply completing the assessment in complete sentences including having a friend or family member complete the assessment. Teacher should just look at the responses across the class in order to look at what misconceptions exist and how to address them.

Scoring Guideline Mid-Assessment

Students will once again be given credit for completing assignment and having a friend or family member complete the assessment. Teacher should look for growth from last assessment; both in the student and the family member assessment. The family member's assessment can serve as an example for the student's understanding (what they have explained to their friend) They should also be looking out for misconceptions that still exist.

Scoring Guideline Post-Assessment

Students should still be given credit for completing the questions in complete sentences as well as having their friend/family member complete the questions. They should not be graded down for incorrect responses as there will be a summative assessment to follow. However teacher should adhere to a guideline of mastery on all three assessments in order to determine where their students are; and how they progress.

Guideline of Mastery

3 is highest mastery; student understands concepts with zero misconceptions evident.

2 student seems to understand concept fairly well; answer lacking some details or perhaps still containing some misconceptions

1-student has some accurate information in their response but answer is not complete and/or contains many misconceptions

0-student did not answer the questions –or- there was no correct information in student's response

What is global climate change?

3- recent and ongoing rise in global average temperature caused by increasing concentrations of greenhouse gases in the atmosphere; causing climate patterns to change and shift.

Is it the same as global warming? Why or why not?

3- They are often used interchangeably however they have slightly different meanings; climate change refers to a broad set of changes INCLUDING global warming, but also including changes in weather patterns, changes in the oceans, and changes in amount of ice coverage in the world, as well as climate shifts affecting ecosystems. Global warming refers to only the increase in the average temperature near the Earth's surface.

What is the cause of climate change?

3- An increase in greenhouse gas concentrations in the atmosphere are causing the atmosphere to become thicker causing there to be more insulation for the Earth, increasing a global rise in temperature.

What can we do to help address climate change?

3-Lists several things that can be done immediately to reduce carbon footprint (reducing water use, electricity use, fossil fuel emissions, over consumption) Lists several larger things that can be done such as switching to more alternative energy sources.

Appendix B

Breakdown of student mastery. (out of 17 students)

Assessment ONE

Student Responses

1.) What is global climate change?

3- 0 2- 14 1- 2 0- 1

2.) Is it the same as global warming? Why or why not?

3- 14 2- 1 1- 0 0- 2

3.) What is the cause of climate change?

3- 2 2- 6 1- 7 0- 2

4.) What can we do to help address climate change?

3- 0 2- 1 1- 15 0- 1

Family Member Responses

1.) What is global climate change?

3- 2 2- 13 1- 2 0- 0

2.) Is it the same as global warming? Why or why not?

3- 9 2- 5 1- 2 0- 1

3.) What is the cause of climate change?

3- 1 2- 10 1- 5 0- 1

4.) What can we do to help address climate change?

3- 0 2- 0 1- 16 0- 1

Assessment TWO

Student Responses

1.) What is global climate change?

3- 13 2- 3 1- 1 0- 0

2.) Is it the same as global warming? Why or why not?

3- 15 2- 2 1- 0 0- 0

3.) What is the cause of climate change?

3- 5 2- 8 1- 3 0- 1

4.) What can we do to help address climate change?

3- 1 2- 14 1- 2 0- 0

Family Member Responses

1.) What is global climate change?

3- 13 2- 4 1- 0 0- 0

2.) Is it the same as global warming? Why or why not?

3- 11 2- 6 1- 0 0- 0

3.) What is the cause of climate change?

3- 4 2- 11 1- 2 0- 0

4.) What can we do to help address climate change?

3- 0 2- 13 1- 4 0- 0

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Assessment THREE

Student Responses

1.) What is global climate change?

3- 17 2- 0 1- 0 0- 0

2.) Is it the same as global warming? Why or why not?

3- 17 2- 0 1- 0 0- 0

3.) What is the cause of climate change?

3- 13 2- 3 1- 1 0- 0

4.) What can we do to help address climate change?

3- 16 2- 1 1- 0 0- 0

Family Member Responses

1.) What is global climate change?

3- 16 2- 1 1- 0 0- 0

2.) Is it the same as global warming? Why or why not?

3- 14 2- 3 1- 0 0- 0

3.) What is the cause of climate change?

3- 12 2- 3 1- 2 0- 0

4.) What can we do to help address climate change?

3- 15 2- 1 1- 1 0- 0