**Using Action Research to See If Predict, Observe, Explain Activities Effect Water Cycle Condensation Understanding**

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**TE 861C- Action Research in the K-12 Science and Mathematics Classroom**

**Introduction to Action Research**

This past trimester I noticed that many students struggled with explaining some natural phenomena within my classroom. In particular, I noticed that my students had particular difficulty explaining condensation in relation to cloud formation in the water cycle. It seemed that no matter how many times I explained and re-explained water cycle condensation, I would still have a large percentage of students who still could not explain the phenomenon correctly.

At the beginning of the water cycle unit, the students created a water cycle diagram showing me what their prior knowledge was of the water cycle. All of my students suggested that clouds are made of water vapor and are made through evaporation or simply did not include condensation at all. After the students were formally introduced to the water cycle in class, the students were asked to edit their original drawings. After they edited the drawings, I noticed that only 55% of the students corrected their drawings and added condensation as the process that creates clouds and that it is made of water droplets collected on dust. After a week or so after addressing condensation, the students had to use their knowledge about water cycle condensation in a game. The students dropped back down to only 10% showing understanding of this concept. This is would make it seem that the students are hard pressed to change their prior knowledge to the correct explanation or understanding.

Thinking about an article that I read in a prior class, it stated that Predict, Observe, Explain activities can challenge student’s incorrect explanations or ideas. Since this article stated that it could change student’s incorrect explanations or ideas, I decided that I would try this kind of activity to use in my classroom to push my student’s past these incorrect ideas to create explanations that are accurate for condensation in the water cycle. Predict, Observe, Explain (POE) activities are activities where you ask the students to predict the outcome of a lab or demo, have the students watch the demo or lab and then, finally explain their observations of the natural phenomena against their prior predictions. The idea is that you show a demonstration(s) or have students do a lab or labs that show various parts of a natural phenomenon and through their observations and predictions that can create and edit their own explanations and therefore creating correct explanations of natural phenomena.

Looking at my classroom concern and this new idea of using POE’s to allow students to edit and create their own explanations, I related these two ideas to come up with the focus of my study. My research question is “Will a POE activity effect how students explain the natural phenomena of condensation in relation to the water cycle?” Through a pre-test, post-test and the POE activity itself, I will be looking for changes in students explanations in condensation in relation to cloud formation in the water cycle. More specifically, I will be looking for students to be able to state that when water evaporates, the water vapor rises. As the water vapor rises, the atmosphere cools causing the water to turn back into liquid water droplets on dust particles continue to condense until the water droplets are so large that they are pulled back towards earth.

**Literature Review**

Overall, there have been reports that condensation is a concept that many students have struggled with. In a journal that reviewed research works by Mills on students understanding of water and water resources, it referenced one set of papers where students from kindergarten through eighth grade were not able to explain evaporation or condensation and many of them could not conceptually understand the water cycle. It cited the reason being “ ‘ older children seemed to be concerned with trying to fit scientific terms into their explanations that they lost sight of the phenomena at hand’ “. In another referenced paper by Van Thiel in this journal, this referenced paper reported interviews that showed strong misconceptions in the ideas of evaporation, condensation, water pollution and the kinetic molecular theory. (Brody, 1993, pp. 11-12) With these reports, it seemed essential that this concept needs to be addressed with an activity such as a predict, observe, explain (POE) activity.

A POE is a type of a formative assessment. A formative assessment is assessment of student’s learning during the learning process itself. This kind of assessment can inform a teacher during the learning process where the student is in the understanding of the topic being taught. In general, this assessment is carried out by the teacher within the classroom during the normal day and is also used to help students achieve the topic at hand. Sometimes this type of assessment can also be called everyday or classroom assessments. (Furtak, 2009, pp. 2-3)

According to Cauley and McMillan (2010), research has shown that formative assessments can be useful in increasing student achievement and motivation. On most levels, formative assessments are thought of as assessment that simply collect data about our student’s understanding, but it has been found that they do this as well as increase student learning. Cauley and McMillan cite four reasons for the increase in student achievement. The first one is that teachers are giving clear expectations to their students by explaining what kind of work they are expecting from the activity. The second one is that formative assessments allow teachers to give feedback to the students on their progress to learning the content. The third is that it shows students that with more motivation, the better their success on the assessment. Finally, formative assessment allows for student self assessment on their own progress and whether or not they have hit the target. (Cauley & McMillan, 2010, pp. 1-4)This final reason is especially seen in a POE activity .

POEs allow students to self-analyze their preconceived explanations or ideas and readdress them if they are incorrect. (Furtak, 2009, p. 90)The way that this activity does this is through each step in the activity: 1) predict, 2) observe 3) explain. In this sequence, the teacher first introduces the students to an experiment or demonstration. After this, the student completes the first step of the POE by predicting the outcome of this experiment or demonstration using their prior knowledge. Students are sometimes also asked to explain these predictions in this step. In the second step, the experiment or demonstration is completed either by the students or the teacher and the students are asked to make observations of this experiment or demonstration. (Liew & Treagust, 1998, p. 2) In the final step (the explain step), students are asked to analyze any difference between their prediction and observations. Then, they must try to explain their differences. (Kala, Yaman, & Ayas, 2013, p. 539) This means that they must explain what they saw compared to what they know.

This process and especially the final step allows for the following to happen in the student’s understanding. By comparing their predictions to their observations, it can help students realize that their current explanations or ideas do not fit what actually happens and causes them to move forward in what they think about the concept. This means that it forces students to edit their thoughts and explanations to build better ones. (Furtak, 2009, p. 90)

These kinds of idea changes are called conceptual changes. A conceptual changes is when existing knowledge is changed or modified to create more accurate knowledge or detailed knowledge. In order to get these conceptual changes, it is suggested that four things need to happen. The first one is that students must become dissatisfied with their original ideas or explanations. POEs do this by causing the student to address their prior knowledge before the observation and then, re-address it. The second is that a new conception is “plausible”. The third is that the new conception is intelligent and the fourth is that it is “fruitful” (Costu, Ayas, & Niaz, Investigating the effectiveness of a POE-based teaching activity on students' understanding of condensation, 2011, pp. 49-51) The new evidence causes the student to create new ideas and explanations that fall into the intelligent, plausible and fruitful categories.

Also, it has been said that teachers can use the responses from the predict and explanation part of the POE to see where their students understanding in a concept. (Kala, Yaman, & Ayas, 2013, p. 559) For example, a teacher may be able to use the predict portion to look for prior misconceptions, lack of knowledge or correct explanations amongst their students. While at the explanation part, a teacher can look for how well their lack of knowledge and/or misconceptions have changed.

There are two particular articles that support this idea that POEs allow for conceptual change. In an article called “Promoting Conceptual Change in First Year Students’ Understanding of Evaporation”, students were tested before and after an evaporation PDEODE activity [a type of POE activity where class discussions are done after the prediction and observation and explanation is completed after a class discussion of the prediction (Predict-Discuss-Explain-Observe-Discuss-Explain)]. The results showed that there were “statistically significant differences” in the pre- and post-test. Therefore, they suggested that “ the strategy helped students to achieve a better conceptual understanding”. (Costu, Ayas, & Niaz, Promoting Conceptual Change in First Year Students' Understanding of Evaporation, 2010, p. 5)In another research article called “ Conductimetric Titrations: A Predict-Observe-Explain Activity for General Chemistry”. College students and AP chemistry students were asked to complete three POE’s for three different kinds of titrations. After the POE activity, it was reported by an author that the students understood the concepts and ideas during a discussion of the concepts. (Smith, Edionwe, & Michel, 2010, pp. 1217-1220)

The strongest evidence that supports the claims that POE’’s cause conceptual change in students explanations as well as supporting is found in a research article by Costu et. al. on the effectiveness of POE activities (specifically a type of POE, PDEODE was used in this case) on students’ understanding of condensation. In the research, 52 students were studied from the same introductory chemistry class and had them perform three POE activities in relation to condensation. (As a side note, these condensation activities are in relation to condensation principles for a chemistry class and not inter-related to the water cycle.) The three POE activities included the following demonstrations: 1) Water build up on the exterior of two room temperature glasses 2) Water build up on the exterior of one room temperature water glass and one glass with ice 3) Water build up on the exterior of one glass with ice in it and another glass with ice it in while it is in a sealed plastic bag. Each one of these POE activities are meant to focus on the concepts that there is always water vapor in the air and water vapor can turn into liquid water when it interacts with a cooler temperature. (Costu, Ayas, & Niaz, Investigating the effectiveness of a POE-based teaching activity on students' understanding of condensation, 2011, pp. 52-53)

The results of the effect of these POE’s were collected from a pre-test before the POEs and a post-test after the POEs as well as the same post-test given at a later date as well as interviews. The results showed an increase in correct answers on the condensation test. For example, on the first item, the number of students who got it correct went from 90% to 98% then to 100%. All items showed an increase to at least 70% of students answering each question correctly. Even in the interviews, they found that all students no matter their entry level of understanding the concept increased their understanding of the concept. It was concluded that “the research findings presented here suggest PDEODE teaching strategies are an effective means of reducing the number of alternative conceptions students hold about condensation.” (Costu, Ayas, & Niaz, Investigating the effectiveness of a POE-based teaching activity on students' understanding of condensation, 2011, pp. 59-63)

**Description of Research Context**

The class that I will be doing my action research on is a class from Armada Middle School. Armada Middle School is a school that includes 6th, 7th, 8th grades in a rural community. The school is mostly Caucasian students with 2 Asian students and 3 to 4 African Americans. The school itself is small with only about 500 students total for all three grades.

The participants will be my 7th hour general science class. In this class, there are 30 students. These students are all 7th grade students, which means that they are between the ages of 12 and 13 years of age. This class has a mixture of both male and female students. There are 9 female students and 21 male students in this class. This class has a wide variety of achievement levels from students who are in enhanced reading classes ( 3-4 students- numbers fluctuate from trimester to trimester so current numbers are unknown) and have IEPs ( 3 students with reading related IEPs) to students that are high achieving and will do above the work needed to be done by completing optional work, etc. Although, the majority (about 75%) of this class sits at a C or B grade level in my class.

This class was chosen because they are my class with the closest to a 75% average as a class. One of my other classes is lower and struggles and the rest of my classes are honors level classes, so this means that I wanted to choose a class that was more middle of the road so I can find evidence that may work for both high achieving students as well as low achieving students. Another reason why I chose this class was because our school has been recently talking about the bubble students or students who sit at the top of the average level, but can be pushed to above average by only a little more effort. This class has many of these students due to their C/B grade level.

These students will be in my classroom while I will be doing this study. My classroom has windows that look out onto the school bus yard, but most of the time the blinds are closed due to this view. My classroom consists in of lab benches and lab stools since it is a science classroom. Although, these benches are rather large and take up the majority of the classroom and make it quite crowded. Also, there is a lot of science related work on the walls. There is also a lot of technology in the classroom including a Promethean board, laptops, and clickers. In this particular case, the Promethean board has been used quite a bit in the past to guide students on creating class foldables on water cycle, which includes the topic of condensation.

I plan on conducting this research study during the months of March through May. I am using three months to ensure that I receive enough data to make conclusions on. I am specifically using these threes months because we are scheduled to teach condensation in reference to the water cycle around the month of March and I can collect follow-up data in April as well as May.

I will be gaining permission from these students to be participants to gather data from by sending home a permission slip. This permission slip will explain the study and that the study is for a master’s course and their names will not be revealed in the study. Within the thorough explanation of the study on the permission slip, it will state that no harm will come to the individuals within the study. This permission slip will need to be returned by the student with the student’s signature as well as the parent or legal guardian. Only if this permission slip is returned will I have consent that I can use these students as participants. See Appendix E for the permission slip.

**Methods/Treatments**

Planned Innovation:

The planned innovation to change the students’ explanations regarding condensation is using the POE activity. Three POE activities will be used in sequence. Each POE activity will discuss different parts of condensation. Before the POEs, we will have addressed the water cycle as a whole and brushed on the idea of condensation, but we will not have gone in depth about it.

The first POE that the students will do is the “Cold Water in A Glass” POE. The students will be told that cold water from the fridge will be placed in a room temperature beaker. Then, the level of the water will be marked on the beaker with a dry erase marker. The students will then need to predict what will happen to the glass over the next five minutes and why it will happen. After they predict on their own, we will discuss their predictions and reasoning behind their predictions. Then, the teacher will do the demonstration and the students will make observations and after the five minutes, the students will need to explain the differences between their predictions and their observations and their explanations will be discussed in class. This POE was chosen first for the students to get out their ideas about the process of condensation. The line is drawn to show the students that the level of the water in the beaker does not change to force the students to hopefully think that the water had to come from the air and when it hit he cold glass, the water vapor turned into a liquid.

The second POE is the “Watch Glass above Boiling Water” POE. The students will be told that boiling water will be placed in a beaker and boiled on a hot plate. While it is boiling, a cold watch glass will be taken from the refrigerator and placed on top of the beaker. Students will need to predict what happens to the watch glass and explain their prediction and we will discuss these as a class. Then, the teacher will complete the demonstration and the students will need to go through the same observation and explanation process with discussion as described above. In this POE activity, students will need to focus on the idea that water vapor rises and condenses once it comes in contact with cooler temperatures. Students will also be able to address the fact that the water droplets grouped together and fell back into the beaker. This allows the students to see that building of water droplets causes gravity to pull them back down. This POE was chosen as the second POE because it builds off of the first POEs ideas about condensation happening when water vapor encounters a cooler temperature. This POE adds onto those concepts by adding the ideas that water vapor rises allowing cloud formation to happen in the higher atmosphere.

The third POE is the “ Cloud in a Bottle” POE. Students will be told that hot water will be placed in a pop bottle just to cover the bottom of the bottle. Then, a match will be lit then blown out. Finally, the bottle will be capped and then, it will be squeezed. Students will need to predict what will happen in the bottle and explain their prediction and discuss them as a class. Then, the demonstration will be performed and the students will need to complete the observe and explain steps once again. This POE activity focuses on the ideas clouds are made from water vapor condensing to water droplets on dust. Students should be able to use the prior POEs to know that boiling water will add water vapor to the air in the bottle and that when it was squeezed, they could see tiny water droplets of fog in the bottle. The water droplets condensed on the pieces of dust when squeezed due to pressure. (The idea that pressure or temperature can cause a state change will be told to the students before the demonstration to keep from confusion.) This POE was saved for last because students need to know that water vapor rises, condenses on objects such as the dust, and is in a liquid form.

Data Collection

Overall, it has been decided to use quantitative data to assess the effect of the POEs on the students’ understanding of condensation in relation to the water cycle because the data will be specifically from assessment data. Assessment data was chosen to get a direct/specific understanding of the student’s ideas of condensation in the water cycle. The formative assessment data will be in the form of the POEs themselves. There will also be data from a summative assessment in the form of a test on condensation. A timetable for this data collection and the POEs can be found in Appendix C.

In order to see the effects of the POEs on the students understanding of condensation, a test will be given to the students before, after, 1 month after and 2 months after the POEs. I will be testing them before hand to see their knowledge base before the POEs, afterwards to see if their knowledge changed, and the months later to see if they retained their knowledge. The test will be the same test each time and will review the objectives mentioned above for each POE. A copy of the test is in Appendix A.

Also, the POEs themselves will be used as a secondary source of data, which will show the changes of their understanding during the activity. The responses from each student on each step, especially the “explain” step, will give me data on whether or not the student was able to alter their ideas if need be to the new observation. A copy of the POE worksheet is in Appendix B.

Validity and Reliability.

In order for my data collection to be valid, my data collected must align with my research question, which is “ Will POE activities effect how students explain the natural phenomena of condensation in relation to the water cycle?” Since my POEs each have specific objectives to cover to understand condensation in relation to the water cycle (mentioned above in the planned innovation section), then one can assume that the POEs directly align with the research question itself. In terms of the test, each test question was aligned with one of the objectives from the POEs. Question 1 brings up the fact that water vapor is a gas and invisible. This is an objective needed for the first POE. Questions 2 and 3 align with the first POE as well, but instead of a drinking glass, it is a cold pop can. Question 4 is the same scenario as the second POE, but changed to a pot on a stove. Finally, questions 4 and 5 align with the objectives of the third POE. Since the test aligns with the objectives of the POE activities and the POE activities align with the question, therefore, it can be concluded that the test is valid as well.

As for reliability, triangulation has been incorporated into this action research plan to ensure that my data is reliable. Each student will be taking the test three times to ensure the data is reliable and repeatable. The POEs will also be taken into to account to make sure the data from the test aligns with the data from the POEs. Also, as long as all students and parents give permission to complete this study, there will be 30 students taking this test to possibly show repeatability of the data from student to student.

**Analysis**

The research question has a number objectives associated as outlined by the POEs in the methods section. The objectives are listed below:

-Water vapor is a gas and is invisible.

-Water vapor is in the air.

-When water vapor encounters something that is cold, it causes it to change from a

gas to a liquid.

-When water turns into a gas, the water vapor rises.

-Clouds form higher atmosphere.

-Clouds or condensation forms on dust.

-Clouds are liquid.

Each one of these objectives is found in the test itself. A chart will be used to show the number of students who get the test question right, the total number of students, and the percentage of students that get the objective in the question correctly. Each test will have a chart completed. See appendix D for this chart. Below, there is a chart showing which how the objectives align with each question. Any objective that has two test questions means that the student must get this objective in both questions to be counted as understanding the objective.

|  |  |
| --- | --- |
| **Objective** | **Test Question** |
| Water vapor is a gas and is invisible. | 1 |
| Water vapor is in the air. | 2 |
| When water vapor encounters something that is cold, it causes it to change from a gas to a liquid. | 3,6 |
| When water turns into a gas, the water vapor rises. | 4,6 |
| Clouds form higher atmosphere. | 6 |
| Clouds or condensation forms on dust. | 5,6 |
| Clouds are liquid. | 6 |

The POEs will be analyzed at once because all three POEs hit all of the objectives together. The same chart will be filled out as the chart that is used for the tests. The number of students who get the objective in the POEs will be counted, the total number of students who attempted the POE will be counted, and then, the percentage of the amount of students who accomplish the objective will be calculated. See appendix D for this chart. Below is a chart to show where each objective is in a POE. Again, students must get the objective in both POEs in order to be counted as understanding the objective.

|  |  |
| --- | --- |
| **Objective** | **POE** |
| Water vapor is a gas and is invisible. | 1 |
| Water vapor is in the air. | 1 |
| When water vapor encounters something that is cold, it causes it to change from a gas to a liquid. | 1,2 |
| When water turns into a gas, the water vapor rises. | 1,2 |
| Clouds form higher atmosphere. | 3 |
| Clouds or condensation forms on dust. | 3 |
| Clouds are liquid. | 3 |

# Once all the tests and POEs have been charted, the data can all be placed into a histogram chart to see the changes for each objective over time in order from the lest recent time the objective was addressed to the most recent time the objective was addressed. This will show the change of the objective over time( from pre-test to final post-test in May) in terms of the students’ understanding. This histogram can also show repeatability of the data across the different pieces of data to show that the data is reliable and therefore, a conclusion to this action research.

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Condensation in the Water Cycle Test

Appendix A

Multiple Choice- Circle the best answer.

1. Water vapor is…..
   1. Invisible
   2. A liquid
   3. A gas
   4. Both A and C
2. A cold pop can has tiny water droplets on the outside of the can. Where did the water droplets come from?
   1. The inside of the can
   2. The table the can is on.
   3. The refrigerator from where I got the can
   4. The air
3. How did the water droplets get to the outside of the cold pop can?
   1. Water from another object in the refrigerator got on the can
   2. Water seeped out of the can through tiny holes.
   3. Water from the air turned into liquid water droplets when they hit the can
   4. From frozen water in the outside of the can
4. I’m cooking a soup and there are tiny water droplets on the lid. How did they get there?
   1. They were there before I was cooking
   2. Splashing of the soup
   3. Water vapor rising to the lid
   4. Water seeped through the lid
5. Clouds are made of…..
   1. All dust
   2. All water vapor
   3. All water droplets
   4. Some dust and many water droplets

Short Answer

6. Explain how water from a lake gets to a cloud in the sky.

**Predict, Observe Explain Worksheet**

Appendix B

|  |  |  |
| --- | --- | --- |
| **Predict** | **Observe** | **Explain** |
| What are you predicting?  What is your prediction?  Why did you predict this? | What did you observe during the demonstration? | Did your predict match your observations?  If they didn’t match each other, explain why the observation was different from your prediction. |

Title of Demonstration:

Appendix C- Time Table

|  |  |  |  |
| --- | --- | --- | --- |
| **Date** | **Time Allotted** | **Activity** | **Data Collected** |
| Monday, March 10th | 20 minutes of Class | Water Cycle – Condensation Pre-test | Pre-test Answers |
| Tuesday, March 11th | Full Class Period | “Cold Water in a Glass” POE | POE responses |
| Wednesday, March 12th | Full Class Period | “Watch Glass Above Boiling Water” POE | POE responses |
| Thursday, March 13th | Full Class Period | “Cloud in a Bottle” POE | POE responses |
| Friday, March 14th | 20 minutes of Class | Water Cycle – Condensation Post-test | Post-test Answers |
| Monday, April 14th | 20 minutes of Class | Water Cycle – Condensation Post-test | Post-test Answers |
| Wednesday, May 14th | 20 minutes of Class | Water Cycle – Condensation Post-test | Post-test Answers |

Appendix D

Name of Assessment:

Date of Assessment:

|  |  |  |  |
| --- | --- | --- | --- |
| **Objective** | **Number of Students Who Showed Understanding of the Objective** | **Total Students Who Took the Assessment** | **Percentage of Students Who Showed Understanding of the Objective** |
| Water vapor is a gas and is invisible. |  |  |  |
| Water vapor is in the air. |  |  |  |
| When water vapor encounters something that is cold, it causes it to change from a gas to a liquid. |  |  |  |
| When water turns into a gas, the water vapor rises. |  |  |  |
| Clouds form higher atmosphere. |  |  |  |
| Clouds or condensation forms on dust. |  |  |  |
| Clouds are liquid. |  |  |  |

Dear Parents, Guardians and Students,

Appendix E

During the school year, I will be conducting a research study to examine how 7th grade middle school students learn condensation through the use of a predict, observe, explain activities. This study will take place from the beginning of March to mid-May.

I plan to collect data through two forms, a test and the predict, observe, explain activities. The test will take 10-15 minutes for the students to complete. They will complete the test once before the predict, observe, explain activities, once immediately after the activities, one month later after the activities and two months after the completion of the activities. These tests will not be used as a grade in the class, but simply data for this research study. The POE activity will be an activity that every student will complete in class. It will also not be calculated into the student's grade, but all students will be asked to complete it. If your child chooses not to be part of the study, their predict, observe, explain will not be included as data for this research study.

The purpose of this study is to find a more effective way of teaching the concept of condensation in the process of the water cycle. If the predict, observe, explain activity is found to be effective, it could be used for other concepts within the classroom to improve student's understanding of the concepts.

If you or your child chooses not to participate, there will be no penalty to your child. It will not affect your child’s grade, treatment, services rendered, etc. to which you or your child may otherwise be entitled. Your child’s participation is voluntary and he/she is free to withdraw from participation at any time without suffering any ramifications. The results of the research study may be published, but your child’ s name will not be used. Data collected will be kept confidential and will not be shared with anyone. I will destroy all data within one year of completing the study. If you have any questions concerning this study or your child’s participation in this study, please feel free to contact me at 586-784-2568 or [sdemarco@armadaschools.org](mailto:sdemarco@armadaschools.org)

Sincerely,

Stephanie DeMarco

7th Grade Academy Science

7th Grade General Science

Armada Middle School

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By signing below, I give permission for my child to participate in the study described above.

Parent'/Guardian's Name: Date:

Parent/Guardian's Signature:

By signing below, my child agrees to participate in the study described above.

Child's Name: Date:

Child's Signature:

Letter Adapted from (Mertler, 2012, p. 107)