

NSTA Professional Development Institute on Assessment
Lawrence Hall of Science
March 30, 2005

Middle School Breakout Session
Assessing Students' Ability to Design and Analyze an Investigation

Prior Experiences of the Students

Students have investigated a variety of solids in water to determine how well they dissolve. In some experiments they have used only water as a solvent, and observed varying amounts of solute in a fixed volume of solvent. They have also observed that undissolved solids can be removed by filtration. In other experiments, they have compared water and alcohol as solvents.

All student investigations have used drops as a measure of water and scoops as a measure of solids.

INQUIRY SCORING GUIDES FOR MIDDLE SCHOOL

1. Designing Investigations (DI)
2. Organizing Data (OD)
3. Analyzing Data (AD)

Scoring Guide: Designing Investigations (DI)

What to Look For

Response states a design and specifies data to be collected for the investigation.

Procedures are described completely and accurately.

Level 4 <i>Above and beyond</i>	Student accomplishes Level 3 and goes beyond in some significant way such as: <ul style="list-style-type: none">• identifying alternate procedures.• suggesting improved materials.• relating clearly to scientific principles and approaches.
Level 3 <i>Complete and correct</i>	Student's design is appropriate and has a reproducible procedure, if required.
Level 2 <i>Almost there</i>	Student's design or procedure is incomplete AND/OR has significant errors.
Level 1 <i>On your way</i>	Student's design or procedure is incorrect or demonstrates a lack of understanding of the goals of the investigation.
Level 0	Student's design or procedure is missing, illegible, or irrelevant.
X	Student had no opportunity to respond.

Scoring Guide: Organizing Data (OD)

What to Look For

Response accurately records and logically displays data.

Level 4 <i>Above and beyond</i>	Student accomplishes Level 3 and goes beyond in some significant way such as: <ul style="list-style-type: none">• using innovation in the organization or display of data.
Level 3 <i>Complete and correct</i>	Student logically presents complete and accurate data.
Level 2 <i>Almost there</i>	Student reports data logically BUT records are incomplete.
Level 1 <i>On your way</i>	Student reports data BUT records are illogical OR records contain major errors in the data.
Level 0	Student's data is missing, illegible, or irrelevant.
X	Student had no opportunity to respond.

Scoring Guide: Analyzing Data (AD)

What to Look For

Response accurately summarizes data, detects patterns and trends, and draws valid conclusions based on the data used.

Level 4 <i>Above and beyond</i>	Student accomplishes Level 3 AND goes beyond in a significant way, such as <ul style="list-style-type: none">• explaining unexpected results.• judging the value of investigation.• suggesting additional relevant investigation.
Level 3 <i>Complete and correct</i>	Student analyzes and interprets data correctly and completely AND Student's conclusion is compatible with the analysis of the data.
Level 2 <i>Almost there</i>	Student notes patterns or trends BUT does so incompletely.
Level 1 <i>On your way</i>	Student attempts an interpretation BUT ideas are illogical OR ideas show a lack of understanding.
Level 0	Student's analysis or interpretation of data is missing, illegible, or irrelevant.
X	Student had no opportunity to respond.

Sample Student Work

Question 19. A scientist wants to find out which of three different solids- Solid X, Solid Y, and Solid Z- dissolves best. Describe an experiment that this scientist might do to compare the solubility of these three solids. Be sure to describe the kinds of observations the scientist should make.

Student B1

The scientist could use different liquids like water or alcohol. Then put the solids in different liquids one at a time, and time how long it takes for the solids to dissolve. See if the liquid is still clear, if it has a color or if a solid was a product or any chemical or physical reactions happened.

Student B3

The scientist should see if solids X, Y, and Z are an acid, base or neutral. Then try a serial dilution. Make observations if the solids dissolve better in water or another substance.

Student B7

If a scientist wanted to test the solubility of the 3 different solids, he could experiment by testing them all with the same solvent. If, for example, the scientist decided to use the universal solvent of water he could one by one, place the solid in the water and stir for about a minute. He should use 1 scoop of solute and 5 drops of water. Observations he would have to make is how the solids looked before and after the experiment. Also, it is crucial that he use the same solvent, and stirs for the same amount of time, therefore he would be able to get accurate results. In other words the experiment should only have one variable – the different solids.

Student B11

1. Gather all materials.
2. Put 10 drops of water into cup A. Do the same with cups Band C.
3. Put one scoop of X into cup A. Stir for 30 seconds using stir stick.
4. Observe whether or not X dissolved. Describe color of water and if particles are still floating.
5. Put one scoop of Z into Cup C. Stir for 30 seconds using stir stick.
6. Repeat step 4
7. Put one scoop of Z into cup c. Stir for 30 seconds using stir stick.
8. Repeat step 4.
9. Observe which solid dissolved best and which solid dissolved the least.
10. Clean up materials

Student B19

He/She could put 5 scoops of solid X in cup 1, 5 scoops of solid Y in cup Z, and put 5 scoops of solid Z in cup 3. Then he/she could add 10 drops of water to each cup and stir. After a while, the scientist could observe if any of the solids dissolved at all. He/She could also observe the color to tell if it has dissolved. If it's colorless or transparent, then it is a dissolved solution. After observing, stir 30 seconds and observe more.

Student B22

The scientist could take 5 different liquids and test solid Y, X, and Z and see which one dissolves best out of all of these. He would have to observe color, if any particles are left and if it is clear.

Student B35

The scientist can put them all in different cups of water (same amount of water and same amount of solid) and see what happens. He could do that with a bunch of liquids and then filter them. When he filters them, the filter with the least amount of solid is the one that dissolves the most.

Student B36

The scientist should first put each solid in its own cup of water. The scientist should look for the water to change color, the solid to change size or shape, and if it is a saturated solution. Then, he might try dissolving them in alcohol to see if he gets different results. With the new information he received, he could compare the three solids

Question 20. Use materials provided by your teacher to carry out your plan for Item 19. Record your results and your conclusion. Be sure to include any changes you make to your investigation plan.

Student B1

My results were solid Z when mixed with water was a mixture not a solution it has a milky and cloudy look and is white and not clear. Solid Y dissolved the best because it completely dissolved after stirring for 1 minute. It is clear and has a slight coloring to it. So, it is a solution. Solid X dissolved partially because the water has somewhat of a coloring and some sank to the bottom too. It is white and it is a solution because the some of it dissolved and the water changed color. I would change it by not having him time it just stir for 1 minute each instead.

Student B3

Cup 1 (X)

- There is lots of solid left.
- The solid is gathered at the bottom.
- Did not dissolve; milky white.

Cup 2 (y)

- The solid is completely dissolved.
- The liquid is clear.
- There is no solid; looks just like water.

Cup 3 (Z)

- The solid is completely dissolved.
- The liquid looks like milk; cloudy.
- The solid dissolved but turned the water white; not clear.

Student B7

Before starting the experiment, I chose to observe the solids. Solid X is a white, powdered mixture very similar to that of baking soda. Solid Y is a pale white color it contains of small crystals and resembles salt. And lastly, Solid Z is somewhat like Solid X, however it has more chunks and looks more like flour. After adding 5 drops of water and stirring for a minute solid X has left a milky white tint. Very few of the particles dissolved, but most settled at the bottom. Results for Solid Y was that at first the solid became hard and remained at the bottom but soon it began to dissolve and pretty much all of the particles are dissolved. Solid Z showed as a pale white and completely dissolved. In my opinion, Solid Z was the most soluble because it was able to change the color and completely dissolve, solid Y was second because it mostly dissolved but however had a few particles left.

Student B11

Cup A- Solid X

Cup B- Solid Y

Cup C- Solid Z

Cup A- after stirring the mixture for 30 seconds/ almost all of the particles were still there. The mixture was clear with white/clear crystals like particles still in the cup.

Cup B- after stirring the mixture for 30 seconds, I observed that the particles were all gone. The mixture was clear.

Cup C- after stirring the mixture for 30 seconds, the mixture was a white liquid. It was solid white. Some parts of the mixture was clear but most of it was white. Overall, I observed that solid Y dissolves the best, Solid Z dissolved second best because there were no particles floating but the liquid was white. Solid X dissolved the least because you could still see particles floating.

Student B19

Cup 1- White colored water, some particles around rim of water.

Cup 2- Clear water, some particles at bottom of cup

Cup 3- completely white, milky

In conclusion, solid Y dissolved the best (cup2). After stirring for 30 seconds and watching, it had the least amount of particles left. They probably would have been completely gone if I had added more water. The other two solids turned the water white so they could not have been dissolved.

A source of error is that I had too many scoops of solids and not enough water. It didn't give the water much of a chance because there was too much solid to be dissolved. The cups that didn't dissolve well might have done better if there was more water added.

Student B22

X= none dissolved all particles gathered at the center. No color change. Looks like little bubbles.

Y= Clear, no color change. About 2 particles not dissolved. All of the rest dissolved.

Z= none dissolved, looks like a milky paste, looks cloudy, white.

I don't think I would have used as many liquids as I did.

Student B35

Results

I followed my procedure and found out that chemical Y dissolves the best. I can tell this because X still had a bunch of grains at the bottom, Y had 1 or 2 grains, and Z still had a bunch of powder in it.

Conclusion

Using these three chemicals and water, I can conclude that Y was the most dissolvable. I think chemical X was sugar Y was salt, and chemical Z was flour.

Students B36

In cups 1, 2, and 3 I put 10 drops of water to start. I put 1 scoop of solid X in cup 1 and stirred it for 30 seconds. The powder sunk to the bottom of the cup, but some of it spread out. The water is clear and colorless, and it looks like only a little powder dissolved. In cup 2, I put 1 scoop of solid Y and stirred for 30 seconds. Solid Y completely dissolved. The water is clear and colorless. In cup 3 I put 1 scoop of solid Z and stirred for 30 seconds. It is not a solution because it turned the water white and it is not clear. It looks like milk, and the powder completely dissolved. In conclusion, solid X does not dissolve all the way, solid Y does dissolve all the way, and solid Z dissolves all the way but does not make a solution.

