



## **Instructor's Manual**

### **Module 6: *Communicating Air Quality to the Public in the Mid-Atlantic United States***

**A. Typical class length:**

45-60 minutes

**B. Target students:**

General public, or entry-level state employees

**C. Module objectives:**

The goals of this module are to have the students learn:

- The definition of AQI
- How the AQI is estimated
- How the AQI is used in the Mid-Atlantic region for informing the public about air quality
- Where current and forecasted AQI can be found for their community

**D. Instructor preparation:**

Go to the course web site and download all relevant materials for Module 6:

Instructor's Slides (Powerpoint)

Student Handouts (PDF)

Instructor's Manual Overview (PDF)

<http://bigmac.cee.mtu.edu/marama/Modules/Modules.html>

Review all the materials, make any changes you feel are necessary for your version of the course, master the material, then deliver your class!

**E. Understand the sub-module objectives**

Each course module is constructed of a series of sub-modules based on modern learning theory. The sub-module typically focuses on a narrow aspect of the module topic. The module can be viewed as the collection of several discrete topics presented in a fashion more appropriate for the range of learning styles among students in your class. Most sub-modules are constructed around a *motivation-theory-application-analysis* learning cycle. While it is good practice to have this cycle for each sub-module, it is acceptable to have a portion of the sub-modules that do not have all four components of the cycle. In general though, it is poor practice to have only the theory sections, as this will likely achieve the low-retention rates found in lecture-based learning environments. The rest of this manual

provides tips and insight into specific slides. Please refer to the *Module 6 Instructor's Slides* to follow along.

### **Sub-Module 1: Introduction (Slides 1-5)**

The primary purpose of these slides is to engage the student almost immediately upon entering the classroom. Educational research suggests that in a typical class, the first ten minutes is lost on most students as they are disconnecting from what they were previously doing. Some important points for this phase of the module:

Slide 1 – Have this projecting before the students enter the classroom. Each module starts with a photograph connected to the content. Most students will subconsciously begin thinking about the course material when looking at a photograph. In this case, maybe the students will be wondering what is causing the girl to cough and why this poster even exists.

Slide 2 – Introduce the topic. This will make sure everybody in the room belongs in the class.

Slide 3 – This slide serves as the initial motivation. Feel free to substitute a similar compelling fact, observation, or finding from your own experiences. This slide should be put up long enough for the students to review, and perhaps some short comment from you. Maybe a rhetorical question is appropriate, for example: is the air getting better around here?

Slide 4 – All modules have a preliminary quiz. The purpose of the preliminary quiz is two-fold: (1) it gets the students thinking more about the subject, and (2) gives you a comparative benchmark at the post-module quiz. Feel free to substitute questions with some of your own, but bear in mind that the total time expended here should be about two minutes. Simply have the students circle the answers on their copies of the student handouts, or produce a handout quiz if you want to tally the results. One way to engage the class as a whole is simply to ask for a show of hands for each answer. The solutions to this quiz can be found in the post-course quiz slide below.

Slide 5 – The course goals slide is a good one to emphasize. Tell the students clearly what they will learn by the end of the class. If you add to, or delete, any material modify the course goals if needed.

### **Sub-Module 2: AQI (Slides 6-12)**

The primary purpose of this sub-module is to address the first two course objectives, namely defining AQI and then showing a simple way that it is estimated.

Slides 6-7 – The importance of this material is the concept of an index, essentially a surrogate for the overall quality of the air. As mentioned on the slides, there are some strong reasons to create a new number to represent the air quality. This material can be presented in a lecture-like manner, but it is almost always better to engage the students

whenever possible. Any easy place in these slides would be to ask the students what some of the advantages of an index could be before presenting the reasons on the slide.

Slides 8-9 – These slides introduce the method that is used to estimate the AQI from the various criteria pollutant measurements. Note that the color-coding in the table (Slide 8) is similar to the colors used in communicating the air quality to the public. An important point on Slide 9 is that the AQI in the Mid-Atlantic region is usually dictated by ozone or particulate. That is, the other criteria pollutants usually have a lower individual AQI. Note that each of these pollutants is measured with different instruments and are in the atmosphere at different concentrations, hence the concentration units of those measurements are often different, as denoted at the bottom of the table in Slide 9. Some of the common units include:

ppm – parts per million  
 ppb – parts per billion  
 $\mu\text{g}/\text{m}^3$  – micrograms per cubic meter

The first two are typically used units for gaseous pollutants (number of pollutant molecules per million molecules of air, for example), the last is more common for particulate matter (the mass of particles of certain size range in a cubic meter of air).

Slide 10 – This is a simple hypothetical example to show how the AQI is estimated. If time permits, the students could be given the concentrations only and then determine the AQI from the table in Slide 9. As there are no equations provided for estimating the AQI for a known pollutant concentration (for the ambitious student these could be determined by doing a linear regression for each pollutant given on Slide 9) interpolation must be used to estimate each AQI for a given pollutant concentration. An example:

We have 1-hr  $\text{O}_3$  of 142 ppb, what's its AQI?

From the table on Slide 9, we know the following:

The table concentrations which bound the above real concentration (142 ppb) and their associated AQI values are:

125 ppb  $\text{O}_3$  has an AQI=100  
 204 ppb  $\text{O}_3$  has an AQI=200

Hence, we know the AQI for 142 ppb  $\text{O}_3$  will be between 100 and 200. But how do we find the exact number? We must interpolate with the data given:

$$\frac{(AQI_i - AQI_l)}{(AQI_u - AQI_l)} = \frac{(C_i - C_l)}{(C_u - C_l)}$$

This essentially says that the proportions of the concentrations must be the same in the AQIs. We know everything except for the desired  $AQI_i$  (the AQI to be interpolated):

$C_i$  is the concentration associated with the interpolation and is equal to 142 ppb  
 $C_l$  is the concentration associated with the lower bound and is equal to 125 ppb  
 $C_u$  is the concentration associated with the upper bound and is equal to 204 ppb  
 $AQI_l$  is the lower bound and is equal to 100  
 $AQI_u$  is the upper bound and is equal to 200  
 $AQI_i$  is the AQI to be determined through interpolation

Substituting these values, we have:

$$\frac{(AQI_i - 100)}{(200 - 100)} = \frac{(142 - 125)}{(204 - 125)}$$

Rearranging the terms, we have:

$$AQI_i = 100 \frac{(17)}{(79)} + 100$$

Therefore,

$$AQI_i = 121.52$$

Let's say  $AQI=122$  to be conservative. Note that this is the value presented in the Table on Slide 10. Similar interpolations must be done for most of the others, except  $NO_2$  where the concentration is lower than any in the Table on Slide 9. Hence, it is assumed there is no AQI value to be concerned about for that pollutant.

Slide 11 – This slide shows the specific guidance connected to the two most problematic pollutants for the Mid-Atlantic region, ozone and particulate matter. Note the more restrictive health warnings to be issued by the state as AQI levels increase.

Slide 12 – This is meant to be a whole class discussion. Give the students 30 seconds or so to reflect, then ask for input. Take some responses from volunteers, then ask some of the quiet students for their opinion. If you feel your class is a little quiet, then you may want to have the students chat in groups first, then offer some ideas from their group. Likely community responses could be keeping kids indoors for recess for example (although many of the high AQI days are during the summer break period), restricting activities at retirement complexes, and probably no changes to behavior for most adults. There will certainly be cautionary statements on the news, radio, and papers. Ultimately, it's up to the public to modify their behavior based on such warnings, though.

### **Sub-Module 3: AQI Communication (Slides 13-19)**

The goal of this sub-module is to address the third and fourth objectives of the course module, how the AQI is used as a communication tool, particularly in the Mid-Atlantic, and where this information is available.

Slide 13 – Introduces why and where the AQI is communicated. Check in your local area (at your state environmental department's web site, perhaps) to find the most recent Action Day. Use that as a talking point. What do the students remember about that day, if anything, for example.

Slide 14 – Action Day concept is introduced. This would be a good discussion opportunity, if recent Action Days have occurred in the class community. Good starting questions would be: Did you know about the Action Day on <date>? How did you hear about it? Etc.

Slide 15 – The analysis slide is typical of the kind of open-ended questions that are good for stimulating class participation. An easy way to include a wide range of students is to have them work in small groups for a few minutes, then offer the group's thoughts (note that group activities always take longer, plan accordingly). In this slide, the goal is to get the students to begin understanding connections between the community's air quality and the personal choices that can influence emissions.

Slide 16 – This introduces the AirNow online resource. It is best if you have a computer with internet connection, so you can (slowly) demonstrate some of the features of the site. If you are teaching in a facility where each student has a computer, feel free to guide them through a few resources at the site. Note that these demonstrations (or tours) can quickly consume class time, so proceed with a plan. If you have no internet connection, then simply encourage the students to explore this excellent web site later.

Slide 17 – This activity is meant to have the students explore AQI data for the region. Take a little time to explain that the data is described by the legend in the upper left corner. There are many observations to be made, a few important ones include:

- There are many places and days with AQI > 100
- The highest AQI levels are found along the east coast
- In the Mid-Atlantic states the four-day pattern reveals an increase, a peak then substantial decrease. What might cause such a pattern? Ask the students. One possibility explaining the decrease would be the passage of a front causing storms (less sunlight, hence less ozone) or simply different transport pattern (instead of transport from the Midwest which can fuel the production of ozone, perhaps air on July 19 was from the cleaner north).

Slide 18 – This slide is an example of the community specific data that can be found at many of the state environment department's web sites. Maryland, for example, has web and email information systems. Research your class's community prior to offering the course and present some relevant resources here.

Slide 19 -- Bring in a newspaper, or demonstrate some of the other media outlets for the AQI in the students' community.

**Sub-Module 4: AQI Forecasting (Slides 20-23)**

These slides address the fourth module objective, forecasting future air quality conditions and where to find such information.

Slide 20 – Introduces in a very simplified fashion how AQI predictions are made. Be careful here, it would be easy to introduce detail that could confuse the target audience. Concepts such as “models” will need some explanation. Describe the information-flow diagram, then see if there are questions.

Slide 21 – This presents the current and near-future capabilities of air quality forecasting. While the advantages of such improvement may be apparent to people with technical backgrounds, this would be a good point to ask the students to think about the advantages of such improvements to forecasting.

Slide 22 – This is simply a visual example of current forecasting capabilities. Describe such graphics thoroughly (What are the colors? What are the numbers, what region does this depict? What date and time?). Since AQI is often set by ozone concentrations in the Mid-Atlantic, this ozone prediction map could easily be converted to AQI predictions (essentially combining this ozone forecast with the method in Slide 9).

Slide 23 – This final class discussion focuses on limitations to the AQI. Again, use small groups to lubricate the discussion, tasking them with the creation of a few limitations (and how they might be minimized), then sharing with the whole class. List the suggestions on a whiteboard or similar, so the students can ponder them before moving on. One mentioned weakness of the AQI method is that it considers the pollutants independently; perhaps there are synergistic effects. In other words, some health impacts (particularly respiratory impacts) are thought to be more severe when two or more pollutants (like high PM and SO<sub>2</sub>) are at high concentrations. There is no consideration of this phenomenon in the AQI method. Perhaps one way would be to have extra columns in the AQI table for known multiplicative pollutants and the product of their concentrations are used to calculate another AQI value before the maximum one is reported. There are certainly other legitimate issues with the AQI, but in the end it is a simple and beneficial tool to communicate air quality to the public.

**Sub-Module 5: Conclusion (Slides 24-27)**

These slides provide a meaningful ending to the learning. Don't underestimate their importance.

Slide 24 – The post-quiz goes here. The students should only need 30-60 seconds. Collect their responses, if assessment is needed, else a show of hands with discussion is fine. The purpose of the post-quiz is simply to force retention of key points. The answers for this quiz are:

- 1.) AQI is the abbreviation for *b.) air quality index*
- 2.) A great online resource of AQI materials and data is *c.) AirNow (.gov)*

- 3.) The states become concerned when *c.)*  $AQI > 100$  as that means at least one of the pollutants has exceeded its National Ambient Air Quality Standard (NAAQS), the level set to protect human health from air pollution impacts

Slide 25 – This slide has some resources for the students to learn more on their own. Add to it, as relevant. Encourage additional learning with references that you know to be particularly helpful. The first site is the AirNow resource. The second site is where the high-resolution Mid-Atlantic region ozone forecast model is explained and results are available. The third resource, the MARAMA Guide, has additional perspective on the AQI and how it serves to inform and protect the public, and makes a great reading companion to this course.

Slide 26 – The moment to reflect is an important pause before concluding the class. It helps the student sort and summarize what they have learned, and if desired can be a good summative assessment for your efforts. For example, as an assessment tool, simply ask the students to write their response to the question on a scrap of paper and leave it behind following the class. Read through the responses to adjust any future offerings of the class. It is always illuminating to learn what the class mentions as the most important thing learned (hopefully it will be about the Air Quality Index). This activity could take some time, so set time limits up front.

Slide 27 – Thank the class for coming and for their participation! This is a simple yet powerful way to end the class.