

Decomposition

Decomposition?

Simply put, decomposition is a general problem solving process where we break down a problem into its constituent parts. You probably do decomposition all the time in your day to day life without even thinking about it!

Have you ever tried baking a cake or cooking a recipe before? If the answer is yes, then you have used decomposition. Cooking and baking are complex problems, so we break them down into step by step pieces in order to help us out. Instead of *just* thinking about **baking a cake**, we think in steps like cracking 2 eggs, measuring the flour, and preheating the oven. When we do this, we are decomposing baking into consumable chunks. Easy, right?

Computational Thinking: Decomposition-external link-YouTube

Learning Objectives

At the end of this module, you will be able to:

- 1 Define decomposition
- 2 Decompose a simple problem into appropriate components
- 3 Differentiate between a physical and a logical decomposition
- 4 Evaluate a decomposition with respect to its depth and logical cohesion

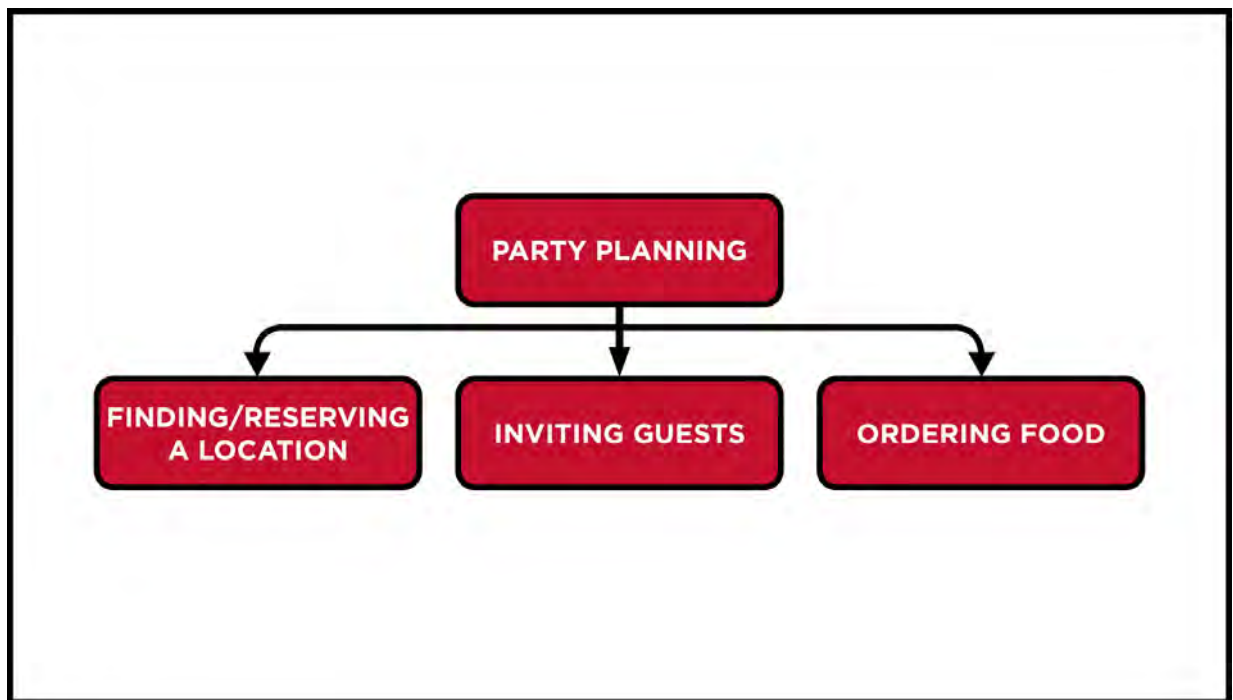
Decomposition is a general problem solving tactic in which a problem is broken down into its constituent components, each of which is now easier to solve.

How Decomposition Works

For example, if you are planning your graduation party, you might decompose this into these components:

- Finding and reserving a location
- Inviting guests
- Ordering food

Note that this decomposition does not indicate the order in which these have to be done. (An algorithm would add that information.) The order in which we have written these may seem to imply an order. Sometimes it is useful to outline decompositions in a form called hierarchy. Here is an example below:



What **Criteria** Makes a Decomposition Appropriate?

1. Sufficiently Detailed

A helpful criteria in answering this question is to ask whether the individual components on the bottom level represent problems that we are now confident that we can solve. In this case, if we are planning a simple party for a few friends or for our family, it is probably fine. However, suppose that we need to plan for a wedding reception. In that case, we may need to add more detail.

Wedding planning

- Location planning
 - Determine general location (near her family, or his, or ??)

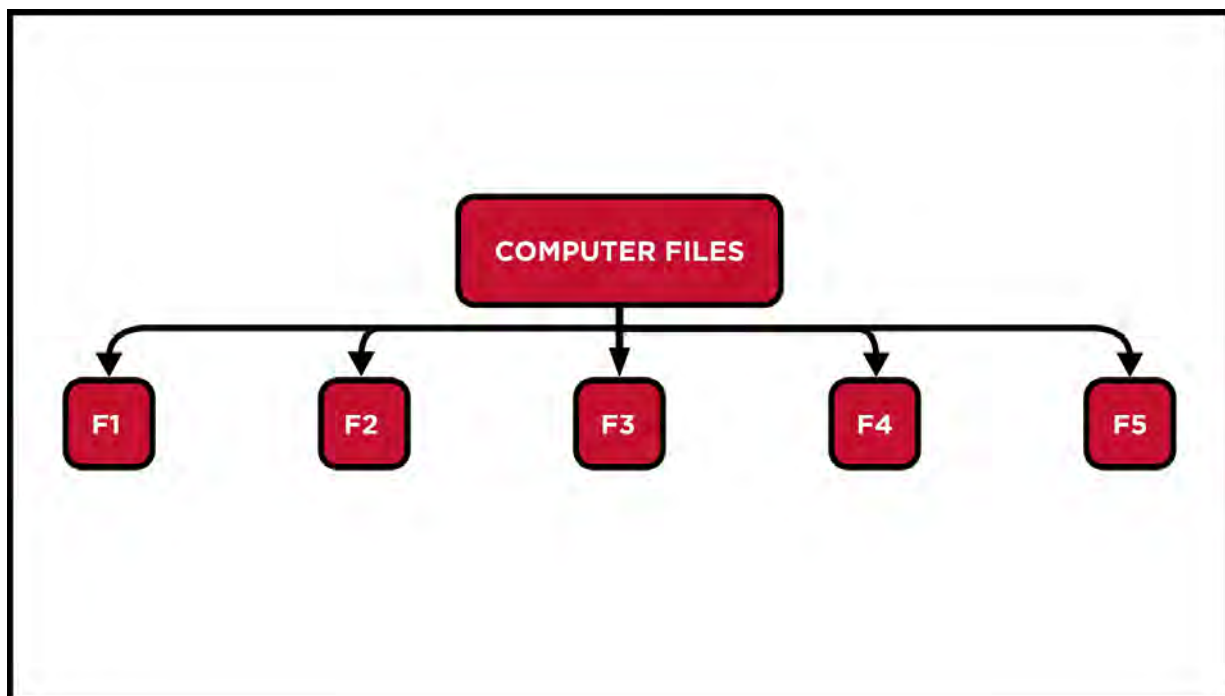
- Making reservation
- Reserving chairs and tables
- Reserving plates, serving dishes, eating utensils, etc.
- Invitations
 - Determining the total number of guests
 - Creating the bride's list
 - Creating the groom's list
 - Paring the list down to the appropriate number
- Food
 - Determining the menu
 - Ordering food
 - Ordering wine

The point is not that one of these is the correct way and the other incorrect. The level of detail depends on the context. To repeat, a useful criterion is to determine if the bottom level of components are those that we are comfortable solving. If not, we decompose further.

The bottom level of components are those that **we are comfortable solving.**

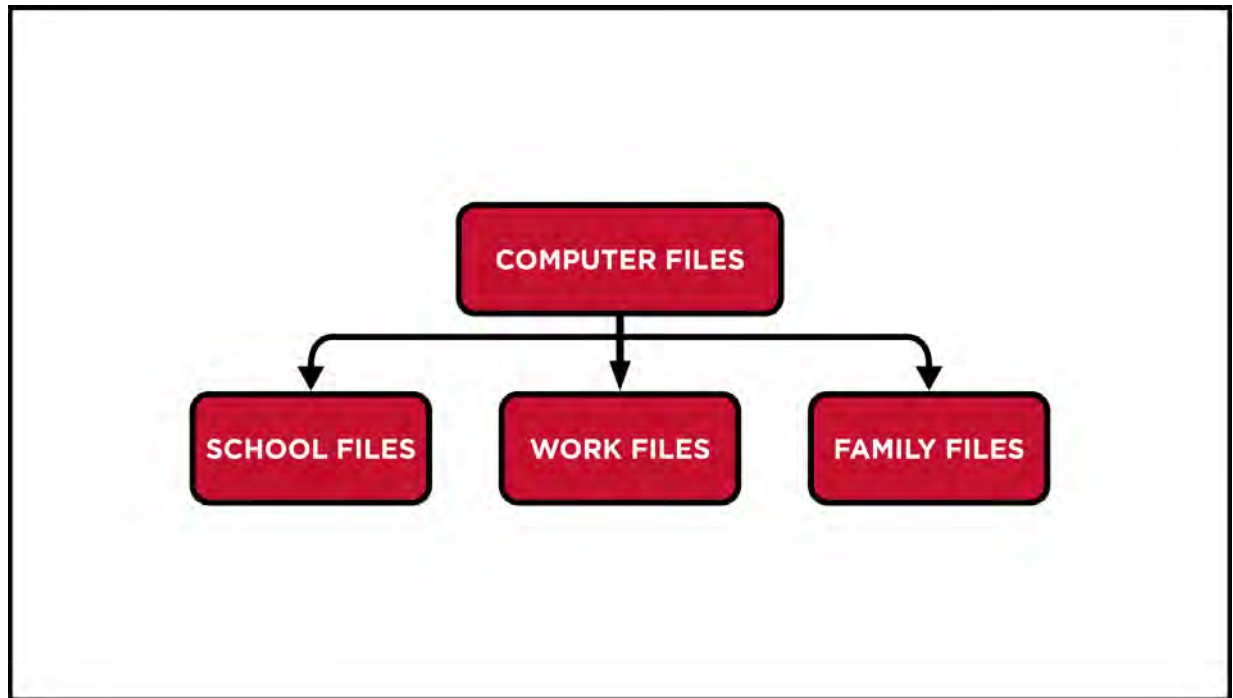
2. Decomposing to Organize

Decomposing into a hierarchy is a useful way of organizing our thinking about a problem or situation. Consider the problem of finding files on your computer. If you have a few files, this is not a problem. You don't need to put them into "folders". However, as you accumulate more and more files, a hierarchical organization will make finding files much easier. For example, suppose that you have 100 files on your computer including files with homework assignments for school, files about your work with a charity (lists of members, flyers about charitable events), and files about your family (pictures, etc.) If these are not organized into folders, finding the one you want will involve looking at the names of each file. If your files are not named well, you may need to open those files. We would describe this as a flat organization. If we pictured this, it would look something like this:



Contrast this with the situation in which you have three folders in which these files are organized:

- School files
- Work files
- Family files



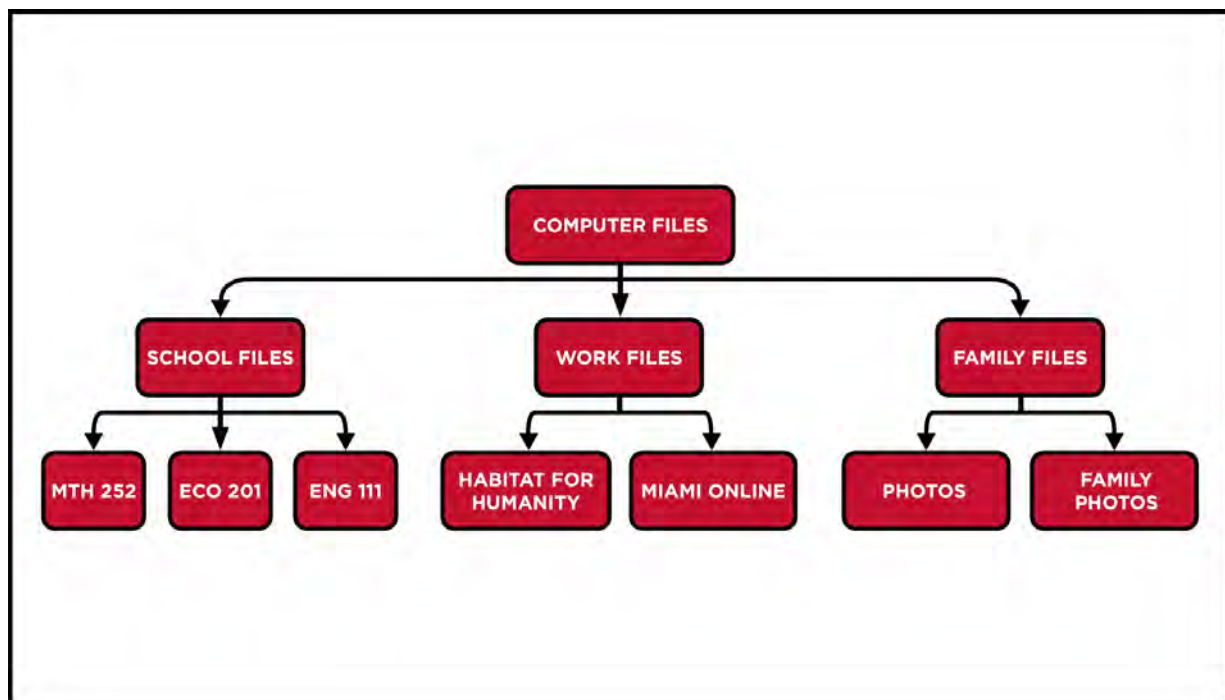
Finding the appropriate file is considerably easier. However, as you accumulate more files, it may be useful to add more levels to the hierarchy, that is, to add additional folders inside these folders.

- **School files**
 - MTH 252
 - ECO 201
 - ENG 111
- **Work files**

- Habitat for Humanity
- Interalliance

- **Family files**

- Photos
- Important documents



The use of a logical hierarchy structure can make finding files much easier. Is this hierarchy sufficient? You may decide that it is still too difficult to find files. For example, you may want to retain files from your past classes but still have quick access to current classes. And you may have so many pictures that you would find it useful to organize those by the family member or by the year when they were taken. So, another refinement of this decomposition could be this one:

- **School files**

- First-year courses

- MTH 252

- ECO 201

- ENG 111

- Second-year courses

- PHY 191

- PSY 252

- Third-year courses

- ENG 313

- HST 345

- **Work files**

- Habitat for Humanity

- Interalliance

- **Family files**

- Photos

- 2022

- 2021

- 2020

- 2015-2019

- Important documents

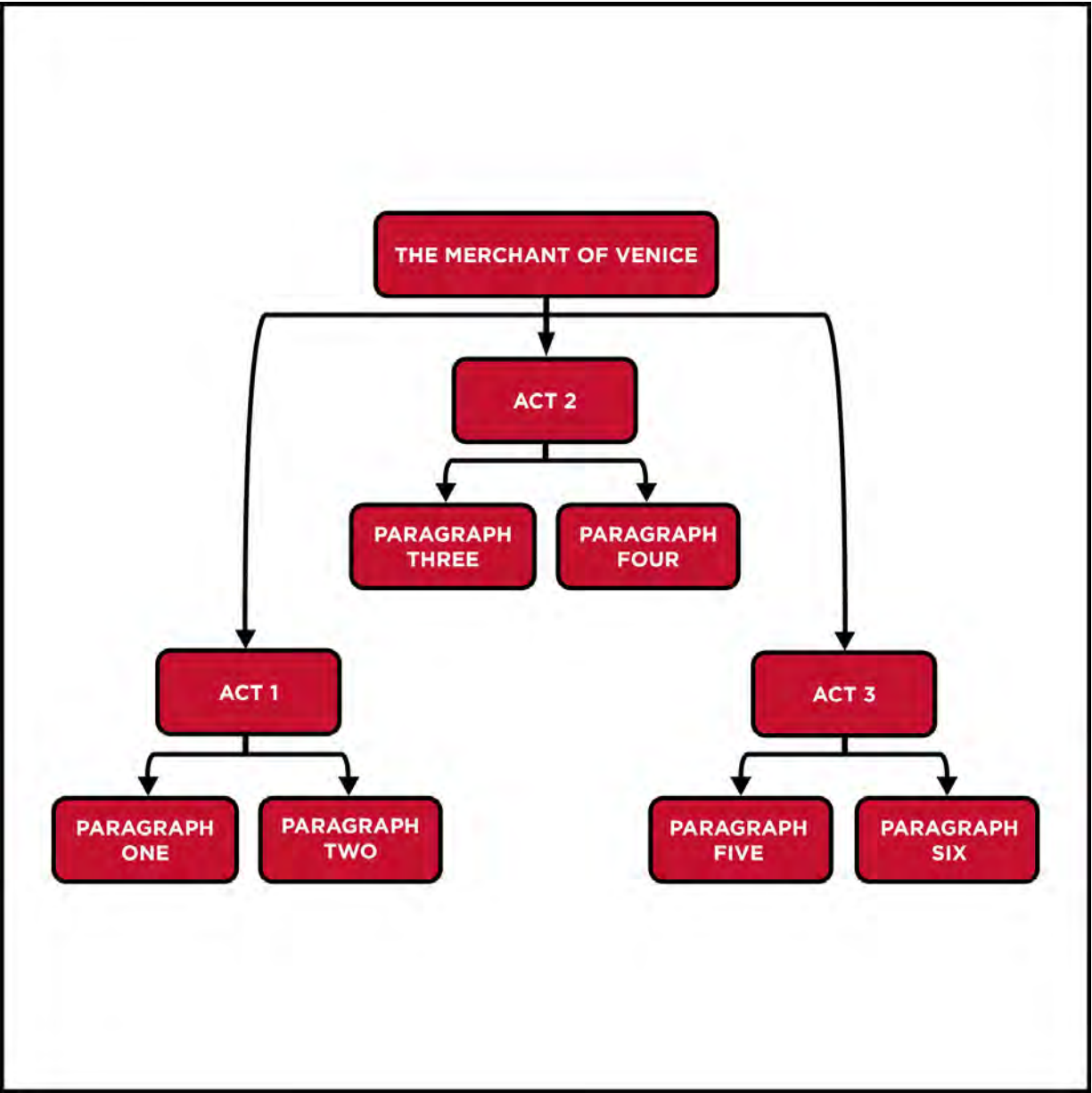
Of course, it is possible to decompose our problem into components that are unnecessarily too small or to extend our hierarchy too deep. For example, in the wedding planning example, it may be helpful to break the location planning down to the level of each table (that is, who is to sit at each table at the reception) but to go to the level of which fork is assigned to Uncle George is ridiculous.

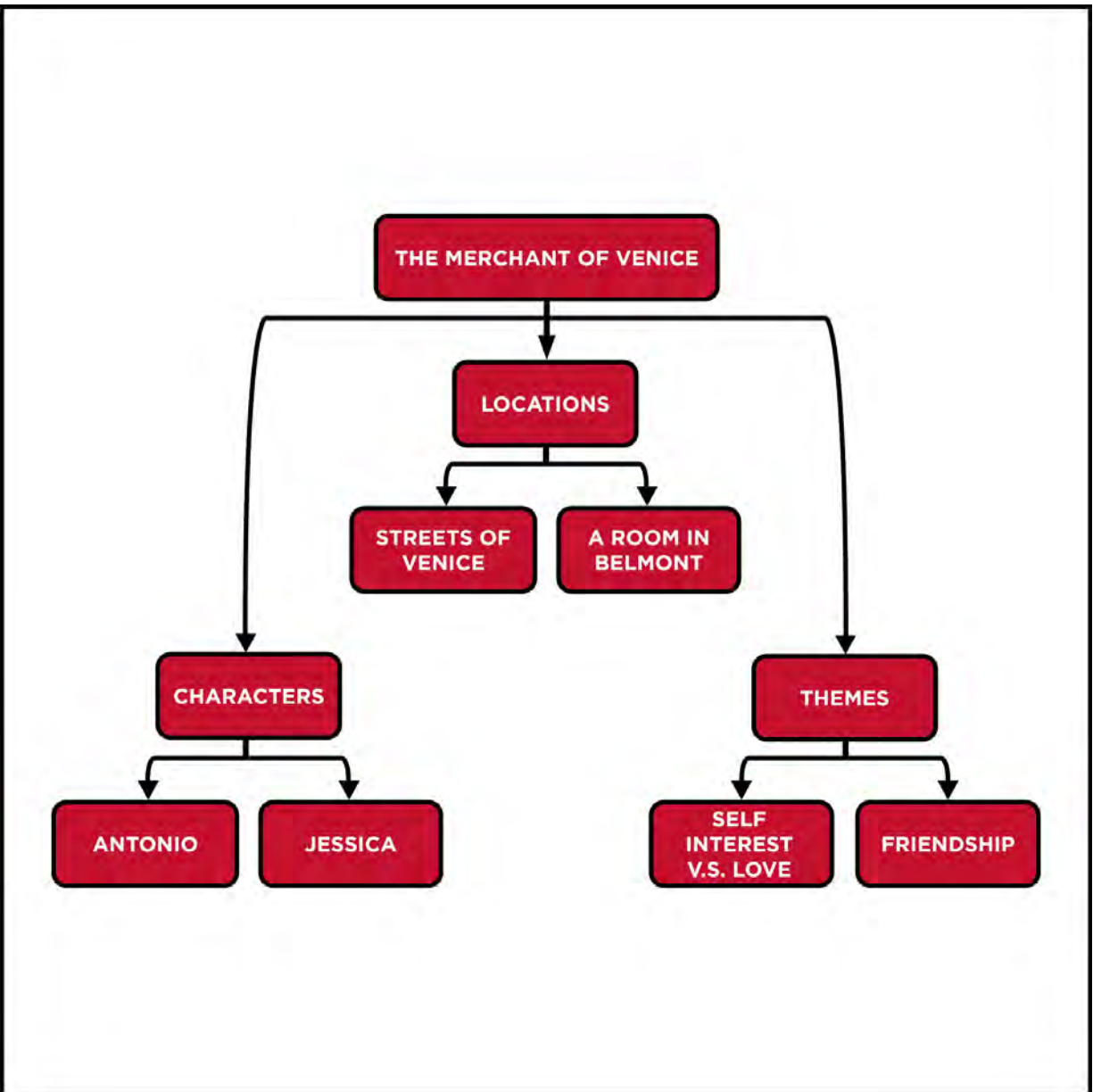
So, we now have two criteria to judge the quality of a decomposition:

1. Are the bottom level components at a level that we are confident we can solve?
2. Have we used a hierarchy in an effective way?

3. Logical and Physical Decomposition

There is one more criterion to consider. That is the difference between a logical and a physical decomposition. Consider the following two decompositions that students might use in organizing an essay about a particular Shakespeare play.





We would describe the first as a physical decomposition of this play. It is accurate, the components at the bottom level are at a level that we can understand, and this has a hierarchy that has an appropriate depth and organization. However, the problem of writing this essay has not been broken down into logically coherent pieces. How does this help the student organize what he/she wants to say about this play? Contrast that first one with the second one that we would describe as a logical decomposition. When the student begins to write the essay, each box gives a clear idea of the point of that section of the essay.

Conclusion

Thus, our criteria for judging the quality of a decomposition are these:

1. Are the bottom level components at a level that we are confident we can solve?
2. Have we used a hierarchy in an effective way?
3. Are the components logical rather than physical in nature?

Lesson 2 of 2

Knowledge Check

A quick knowledge check on decomposition!

Question

01/03

What is the definition of decomposition

- Decomposition is a general problem solving tactic in which a problem is broken down into its constituent components, each of which is now easier to solve.
- Decomposition is taking computer applications apart in order to understand them better.
- Decomposition is the slow process of computers becoming slower due to advances in technology

Question

02/03

Select all the appropriate components of a decomposition of baking a cake

- Locking the front door
- Measuring the flour
- Washing your hands
- Preheating the oven to 350 degrees

Question

03/03

What makes a decomposition logical?

- A decomposition is logical when it has an appropriate depth
- A decomposition is logical when the problem has been broken into coherent pieces that fulfill the purpose of the decomposition
- A decomposition is logical when it has more than 3 levels