LEARNING MODULES

GK-12 DISSECT at New Mexico State University

Title: Introduction to Algorithms

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Discipline or Area:

Teacher: Timothy Staley

School: Onate High School

Subject of class: English Literature

Grade: 12

COVERAGE OF COMPUTATIONAL TOPICS

This module was designed to introduce students to the step-by-step nature of algorithms used to solve problems. Clarity and correctness of algorithms was also discussed.

OBJECTIVES

Students will learn the definition of an algorithm, how algorithms are used in their every day life, and how to make an algorithm better.

EQUIPMENT AND MATERIALS

Towel, tarp, or some flexible material that can be stepped on
1 sheet of paper per student

BACKGROUND AND REFERENCES

During the discussion, students learn that they use many English-related algorithms in their daily life, including algorithms to write essays, evaluate sources on the Internet, find a quote in a novel, and more.

PROCEDURE

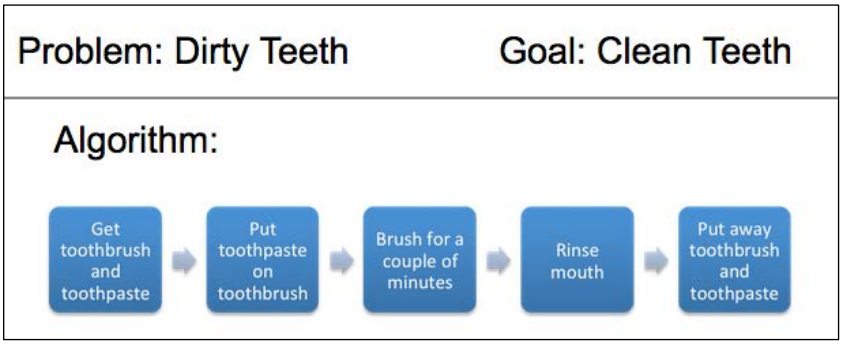
Detailed instructions on how this module is taught.

Before algorithms were formally introduced, the students were walked through a team-building activity. The activity required the instructor to spread out the tarp, or towel, over the floor and ask for five volunteers. The instructor continued with the story and problem to give the tarp some context:

> "Imagine that you and your friends are hard-core soccer fans, so you decide to take a trip to attend the World Cup games in Brazil. Unfortunately, you arrive in the wrong city and now your only form of transportation is a raft that floats down the piranha-infested Amazon River. Along the trip you realize that the raft is upside down, so your goal is to flip the raft while floating on the river without stepping off." Note the story may be modified to fit the interests and age level of the students. For example, the tarp could represent an upside down flying magic carpet, an upside down boat in shark-infested waters, etc.

After the first group of students successfully completed the activity, other students were given the opportunity to attempt faster completion or a harder version (i.e., smaller raft, more students on the raft). At the conclusion of the activity there was a discussion about the steps and strategies that each group utilized to accomplish the goal.

At this point the definition of an algorithm was formally introduced as "a process or set of rules to be followed in problem-solving operations", followed by real-world examples of algorithms. First, the tooth brushing algorithm was discussed in detail, because it is a simple process that all students are familiar with.



Next, the class switched gears and began the paper airplane algorithms activity. After passing out one sheet of paper to each student, the students were shown a Mighty Mite paper airplane and were instructed to follow explicit directions to create their own Mighty Mite. Once the airplane directions were released, but before the class began to construct their airplanes, the class had to break down the activity and determine which aspects qualified as the problem, goal, and algorithm.

Problem: the sheet of paper is unfolded
Goal: to end up with a Mighty Mite airplane
Algorithm:

1. Fold it in half lengthways
2. Open it out and fold it in half from top to bottom
3. Fold it in half horizontally
4. Open it out
5. Fold the left edge to the center
6. Fold the top left corner to meet the middle crease
7. Do the same thing on the other side
8. Fold the top flap down to meet the intersection
9. Flip fold the flap again
10. Turn the plane over
11. Fold it in half so both sides meet
12. Fold one of the wings in half
13. Flip the plane over
14. Do the same thing for the other side

The directions were intentionally a bit ambiguous, because those instructions were taken from Kidspot's video tutorial (http://bcove.me/hsu3uoot) to create a Mighty Mite. The ambiguous instructions are sufficient, because the video compensates with a demonstration of the specific folds and orientation of the paper. Thus, the fact that no student was able to successfully recreate a Mighty Mite was not surprising. The class pointed out that the algorithm wasn't easy to follow because the instructions were not clear. Then the discussion was driven to relate this problem to the essays they are assigned; similar to the instructions given, students aren't able to use video, images, or other tools to get their point across, so they need to write precise language to present their ideas. When prompted with the question, " what could have made the airplane algorithm better?" the class worked together to create a better algorithm with a better sequence of steps.

Better Algorithm:

1. Start with the paper in a vertical position
2. Fold it in half vertically (the left edge should meet the right edge)
3. Unfold it
4. Fold it in half horizontally (the top edge should meet the bottom edge)
5. Unfold it
6. Fold the left side so that the left edge meets the center crease
7. Rotate the paper clockwise 90 degrees
8. Fold the top left corner of the folded portion to meet the center of the paper (the intersection of the first two folds)
9. Repeat step 8 for the top right corner
10. Fold the top forward so that the top edge meets the, now, horizontal center crease and the intersection of the first two folds

11. Fold the top forward along the, now, horizontal center crease
12. Turn the plane over
13. Fold it in half vertically so that both sides meet and are symmetrical
14. Choose one side and fold the side down so that the edge with the plane was folded in half on that side
15. Repeat step 14 for the other side of the plane

A completed Mighty Mite
(http://www.kidspot.com.au/kids-activities-and-games/Paper-planes+36/How-to-make-a-mighty-mite-paper-plane+12249.htm)

If time permitted, students would have been allowed to test their new algorithm in class. Instead, the class was assigned a well-known algorithmic thinking activity: they were required to write an algorithm to make a peanut butter and jelly sandwich.

What were the "learning goals?"

The goals of this lesson were to understand the concept of algorithms and to be able to write them clearly.

How did you introduce CT?

Computational thinking was introduced informally through all activities of this module, and the discussions were used to formally explain the relation to algorithms.

How could you assess the understanding of CT in this module?

The understanding of computational thinking in this module can be assessed by the amount of class participation and the quality of the student-created algorithms to make a peanut butter and jelly sandwich.

NOTES AND OBSERVATIONS

What were challenges you encountered in the overall development of the module?

Students aren't usually fond of their English courses, because it is not an elective course. The activities were not 100% related to English, but that may be one of the reasons that the students enjoyed them (they had the chance to take a break from the normal literature curricula). However the students were provided with an example of how the concepts can be tied back to English.

What was successful?

The students were unable to complete the paper airplane because the first algorithm was too ambiguous, and they were able to quickly determine the reason why. They also enjoyed the challenge of folding a paper airplane model that they had not seen before.

How was the students' reception to the content of the module?

The students were receptive to all aspects of the module except for the first activity that involved a group of students to stand on the towel. It became clear that high school students don't like to participate in activities that require them to be so close to other students; they are very particular about their personal space.