

Patricia Wing is very proud of her third-grade class. Her students have done very well on state tests, and they are succeeding in all of their subjects, especially science, Patricia's own favorite. So she decides to give her students a challenge they'll really enjoy. "Class," she says, "I'm so excited to see the good work you've all done in science. Today, I'm going to give you a problem to solve in your teams that will stretch your minds, but I know you can solve it. "At each of your tables you have a pendulum, several weights, and a stopwatch. You can change the weights on the pendulum, the length of the string, the push you give the weight to start it swinging, or anything you like. My question to you is this: What determines how many times the pendulum goes back and forth in a minute?" The students get right to work with excitement. They try more weight and less weight, more push and less push, longer strings and shorter strings. Each team appoints a time keeper who writes down how many swings there are in a minute. The

students argue with each other: "It's the weight!" "It's the push!" "It's the string!" The groups are working hard but haphazardly. None of them gets the right answer (which is that only the length of the string matters). Patricia is astonished. The students know a lot about science, try hard, and work well together, yet they cannot solve the problem.

Example taken from Slavin's (2018) Educational Psychology: Theory and Practice

Comment on the situation

Patricia Wing's students could not solve the pendulum problem not because they were not smart enough or did not have enough options, but because they had not yet acquired the cognitive abilities that enable them to manipulate various factors at the same time. It is only during the formal operational stage (to be explained in the next documents) that adolescents can proceed systematically, manipulating one factor at a time to reach the desired outcome.