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A New Fine Question as Pedagogical Foundation

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The following case exemplifies three key pedagogical issues central to my personal philosophy of education. The first is that difficult questions from students can lead to powerful learning experiences, if they are handled in the right way. Instead of dreading questions for which they don't have answers, teachers should welcome them. These questions can be powerful catalysts for students' learning as students and teacher seek to find the answers together. The second issue is that teachers must be flexible and willing to modify plans and schedules when serendipitous learning opportunities present themselves. These rare opportunities are too precious to fall victim to a rigid schedule. The third issue modeled in the case is that good teaching involves an element of risk. When the inevitable question that the teacher cannot answer arises the teacher must make a choice—admit that they do not know and be ready to work with students to find the answer, or deflect the question and save face. This case points to the power of choosing the former.

> In the High and Far-Off Times . . . O Best Beloved . . . there was a new Elephant–an Elephant's Child–who was full of 'satiable curtiosity, and that means he asked ever so many questions. And he lived in Africa, and he filled all Africa with his 'satiable curtiosities. . . He asked questions about everything that he saw, or heard, or felt, or smelt, or touched, and all his uncles and his aunts spanked him. And still he was full of 'satiable curtiosity!
>
> One fine morning in the middle of the Precession of the Equinoxes this 'satiable Elephant's Child asked **a new fine question that he had never asked before.** He asked . . . (emphasis added)[1]

I have encountered a fair number of Elephant's Child questions—new fine questions never asked before—in my 36 years of teaching. The most memorable one came from a fifth grade student at TASOK (The American School Of Kinshasa).

The class that year was the kind teachers long to have. The students were exceptionally bright and motivated and had a love of learning that is too often absent in formal school settings. It is not unusual, then, that that special Elephant's Child question, and the amazing learning it fostered, is still so vivid in my memory many years later.

About half way through that school year, timed to coincide with a launch of the space shuttle, I began a unit on the physics of flight. It was one of my favorite science units and one I had taught many times before. The unit normally started with the history of flight and then progressed to forces acting on kites, lighter-than-air balloons, gliders, airplanes, helicopters, and finally rockets. Each part of the unit was accompanied by hands-on activities, many of which I had written for the *AIMS* magazine and the AIMS book, *The Sky's the Limit with Math and Science*.

As we progressed through the unit and got to the section on airplanes I introduced the students to Bernoulli's Principle and demonstrated its relationship to airplane flight. (Bernoulli's Principle states that the movement of fluids affects their internal pressure—the faster the movement, the lower the pressure.) I explained that the shape of an airplane wing when moving forward through the air caused air to flow faster over the curved upper surface of the wing than it did over the flatter lower surface and that this difference in air speed and pressure created the lift that allowed planes to overcome the pull of gravity and take to the sky. I then went to the board and drew a diagram showing the cross section of a wing, complete with airflow lines and arrows indicating lift and gravity. Being a firm believer in the power of hands-on science instruction I had students tear long, thin strips of paper. I then had them hold the strips by one end and blow across them. As students did this they became excited as they saw the strips lifted against the pull of gravity as the faster air flowed across their top surfaces. What a perfect end to a great lesson, I thought. My smugness was interrupted, however, when Heather (one of the brightest students in the class) asked, "If all that's true, Mr. Youngs, then how can an airplane fly upside down?" She came up to the chalkboard and drew a diagram of the cross section of an inverted wing, complete with the airflow lines. As she did this she explained that if the wing were inverted the air would still travel faster over the top surface of the wing, which was now pointing toward the ground. Because of this, the force of lift would act in the same direction as the force of gravity, which should cause the plane to crash. She finished by saying, "But, I saw an airplane flying upside down at an air show and it didn't crash. How come?"

Heather's question caught me completely off guard. I had never thought about the forces acting on an airplane in inverted flight before, even though I had been teaching units on flight for more than a dozen years. I didn't have a clue on how to answer her question.

Fortunately, by this point in my teaching career, I was comfortable enough to tell students when I didn't know answers. I told Heather that she had asked a very special question. I made a big deal out of it and called it an Elephant's Child question: "a new fine question never asked before." I went on to say her question provided us with an opportunity to do an in-depth study of the mechanics of flight. The class agreed, so we began to explore inverted flight instead of progressing on to a study of rockets, the next topic in the unit.

The side trip we took to explore Heather's question was an exciting one. We built paper models of wings and used them to make and test hypotheses about inverted flight. After much thought, work, and observation we felt that we had found the answer. From our experiments with the wing models, we determined that in order for a plane to fly upside down, it had to increase its angle of attack much more than it would in normal flight. Pictures of stunt planes flying upside down confirmed this and showed the inverted planes going through the air with their noses much higher than their tails. With this exaggerated angle of attack, we surmised, the planes were flying more like kites than airplanes. Much of the lift, in this inverted position, was being provided by the action of the air striking the bottom (the top surface in normal flight) of the wing, according to Newton's third law, which states that for every action there is an equal and opposite reaction. The culminating activity for the unit was a guest visit by a Mission Aviation Fellowship pilot who came to share stories and answer questions. Heather was given the right to ask the first question by her classmates and the pilot's answer confirmed our hypothesis about inverted flight.

This extra exploration took several days, making the flight unit longer than I had planned, but it was well worth it. In fact, Heather's "new fine question" initiated one of the most exciting teaching experiences of my career.

NOTES

1. Rudyard Kipling, *The Elephant's Child*, (San Diego: Voyager Books, 1983).