Teacher's Guide

Welcome my fellow teachers and let us review together the objectives of today's lesson.
In addition to using teamwork and learning scientific research, the goal of this lesson is to make the students like mathematics and see the practical uses of mathematics in solving real problems. The movement of sand is one of the most important natural problems facing the Kingdom and neighboring countries where it seriously threatens the vital and civil installations, such as roads, railways and factories, farms, etc. The students will get to know this problem closely in terms of identifying the types of dunes and ways to prevent devastating crawl of sand. Also they well see a small application of integration to calculate the volume of the most well known type of these dunes which are called the barchan dunes.

Prior knowledge we need from students:

All we need from students is that they should be familiar with calculating the area of a triangle and the use of trigonometry functions. The rule of finding the volume using the slice method may be new to the students and may be given as:

Rule: suppose a body lies two planes perpendicular to the x-axis, such as $x = a$ and $x = b$. If the area of the cross section at x in the interval [a,b] is represented by the function $A(x)$ which is continuous at each x, then the volume V of the solid is given by:

$$V = \int_a^b A(x)\ dx$$

One integral formula is necessary to find the volume of the sand dune which is the integral of x^n.

In class activities for students:

What are the activities required from students in this lesson?
There are several collective activities required from students to do within the class. Students need to be divided into groups of four or five students each to discuss these activities:

Activity 1: List three key factors that affect the movement of sand. Here we use brainstorming where we take the students' answers and we record them on the board and then choose the three most important factors such as wind speed, size and sand moisture.

Activity 2: Name three major factors to control the movement of sand towards vital areas. Again, we use brainstorming where we take the students' answers and we record them on the board and then choose the three most important factors such as cultivation, spraying oil over the dunes as well as industrial barriers.

Activity 3: what dimensions (parameters) do you need to calculate the size of the sand dune?

Activity 4: How can we approximate the volume of a dune? Can you suggest a method to do that? Think of a method and discuss your answer with your colleagues in the group.

Activity 5: Try with your colleagues in the group to find the equations of the parabolas. Leave the graph on the screen or you may give the graph on papers. Also you may give the general form of the parabola.

Activity 6: Try with your colleagues in the group to find the height h of the triangle (cross section) as shown in the following figure in terms of the base D. Also you may leave the graph on the screen or you may give the graph on papers.

Activity 7: Try with your colleagues in the group to find the area of the cross section (triangle) perpendicular to the x-axis at point x.

Activity 8: Try with your colleagues in a group to set up a definite integral and calculate the volume of the sand dune.