NCEA Math Lesson Plan

Grade: 9-12 **Subject:** Geometry/Algebra 2/Pre-Calculus

Domain:
Expressing Geometric Properties with Equations

Topic:
Conic Sections-Ellipses

Standard Number(s) and Description:
G.GPE.3 Derive the equations of ellipses and hyperbolas given the foci, using the fact that the sum or difference of distances from the foci is constant.

Vocabulary to be Highlighted:
Ellipse, foci, equidistant, major axis, minor axis, vertex, eccentricity, Distance Formula

Mathematical Practices (#):
1. Make sense of problems and persevere in solving them.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.

Essential Question:
How do we classify conic sections?

Materials/Tools (include technology):
2 push pins per student
6 inches of string per student
Small piece of cardboard (approx. 1 square foot will be sufficient) per student

Connections to Other Math Domains:

Connections to Other Subject Areas:
Architecture
History
Religion

Catholic Identity Component:
Students will study and explore the design of St. Peter's Square in Vatican City. Students will also learn about the history of St. Peter's Square, the Catholic symbolism of its various architectural features, and watch a short video of the announcement of Pope Francis as the newly elected Pope.

Resources (attachments):
Article on St. Peter's Square: http://www.aviewoncities.com/rome/piazzasanpietro.htm

Pope Francis announced as new Pope at St. Peter's Square (1 min 15 sec):

https://www.youtube.com/watch?v=C17YBeTZwyc

Video describing St. Peter's Square (1 min 7 sec):
https://www.youtube.com/watch?v=s9UJZqZT4cU

Activities/Timeline:

Entry Activity: Display an aerial picture of St. Peter's Square on the board for students to see as they walk in the room. Have the following question written on the board, "What is this picture of, where is it located, and what shape is it?" After the bell rings and students have had enough time to try to answer the question, begin to call on students to hear their responses. End the entry activity by showing the video of the announcement of Pope Francis as new Pope (link above).

Lesson Description: Students will be introduced (or reacquainted) to St. Peter's Square during the entry activity though both a still picture and a video for visual and auditory learners. Although many students will know what is contained in the picture, the entry activity will help students access this prior knowledge and immediately set the stage for the Catholic identity connection of the lesson.

For kinesthetic learners, the next activity involves students constructing an ellipse using string, pushpins, and a piece of cardboard. If this is the first time students have been exposed to ellipses, you may refrain from using terms like "foci" and "major/minor axis" until later in the lesson. If students have seen ellipses in a prior course and this lesson is simply a review, use this time as an informal pre-assessment period by asking questions such as, "Does anyone remember the mathematical name for the location of the push pins?" or "What is the longest/shortest dimension of the ellipse called?".

The heart of the mathematical content of this lesson is contained in the direct instruction of how to derive the standard form of the equation of an ellipse. For accelerated classes, the students may perform the proof collaboratively. For non-accelerated classes, give direct instruction. As the standard states, the students must be given the fact that the sum of the distances between the foci and any point on the ellipse remains constant but this should now be more apparent to them after constructing their own ellipses with the string and pushpins.

As a check for understanding, give students an opportunity to replicate the proof in collaborative groups. The intent is that students not use their notes/resources from the just completed direct instruction; however, they will more than likely require assistance at some point, which is an opportunity to check for understanding.

Students may either remain in their collaborative groups or return to a direct instruction format for the definition of variables of the ellipse equation. Additionally, discuss the vocabulary of the ellipse (foci, major axis, eccentricity, etc.). Connect the mathematics with the Catholic identity component by means of the short video on the layout of St. Peter's Square as an ellipse.

For kinesthetic learners, the next component of the lesson moves from students drawing ellipses on cardboard with no constraints to drawing the actual ellipse of St. Peter's Square (to scale) on a piece of graph paper given actual dimensions. Pass out the article on the layout and dimensions of St. Peter's Square (link above) and have students draw the ellipse with the Egyptian obelisk at the center of the ellipse (which is where it is located but it also will eliminate the need for (h, k) in the next part of the lesson. The article describes the obelisk and provides insight into the history of this architectural feature of Saint Peter’s Square. Once students have drawn the ellipse and labeled its dimensions, they are to use this information to generate the standard form of the ellipse at St. Peter's Square.

At this point in the lesson, students are adequately prepared to conduct independent practice on writing equations for a given ellipse. Provide students with a sheet of two separate ellipses (one horizontal major axis and one vertical major axis) on a coordinate plane and have them write the equation for the ellipses. It may be helpful to walk around the room as an informal assessment period.

The closure of the lesson shifts back to the standard taught in this lesson, "Derive the equation of an ellipse." Give each student a handout with the proof of the equation of an ellipse, but only halfway completed. Students will have the remaining time in the class period to finish the proof and hand it in as an exit ticket. Use this as a formal or informal assessment. You can also use it at the start of the following class as an entry activity where students are to find and correct the error of another student's finished proof.

Modifications/Differentiation:
Visual accommodations: Give students who are not able to see the board a handout of the picture of St. Peter's Square during the entry activity. Provide a copy of the proof as a visual accommodation.

Auditory accommodation: If a class webpage or an online class (Moodle, Edmodo, etc.) exists, list the link to the videos so students may listen with headphones or at home on their own. Provide a transcript of the videos before class or turn on closed captioning.

Physical accommodation: If a student cannot use the pushpins, string, and cardboard to create an ellipse, pair students with another student who may assist them in this task.

Differentiation: During the independent practice, provide students who need additional rigor with ellipses that have eccentricities very close to 0 and 1. Modify the closure activity so that students who need additional rigor are provided only the first few steps of the completed proof (versus a halfway-completed proof).

Formative Assessment (what to look for, how/when to look):
The lesson concludes with a formative assessment on the students' ability to derive the standard form of the equation of an ellipse. If time permits, substitute a lengthier assessment or save it for the following class period after students have been provided the opportunity to better synthesize the information on their homework.

Summative Assessment: