Date: 12.12.2013
Teacher: Ezgi Çallı
Number of Students: 17
Grade Level: 9
Time Frame: 40 minutes

Mathematics Learning Plan

1. Goal(s)

- To develop an understanding of the quadratic formula and its applications

2A. Specific Objectives (measurable)

- Students will comprehend and analyze the quadratic formula by knowing when a quadratic equation will have zero real roots, when it will have one real root and when it will have two real roots.
- Students will apply their knowledge of the quadratic formula by solving quadratic equations using the quadratic formula.
- Students will be able to construct and solve quadratic equations to solve real life problems.

2B. Ministry of National Education (MoNE) Objectives

- 10.6.1.1. İkinci dereceden bir bilinmeyenli denklemleri çözer.
  - İkinci dereceden bir bilinmeyenli denklemlerin gerçek köklerin varlığı diskriminantın işaretine göre inceletilir.

2C. NCTM-CCSS-IB or IGCSE Standards:

- Students will be able to calculate quadratic equations by the use of formula. (IB)
- Students will be able to solve problems involving quadratic equations. (IB)
- Students will be able to recognize relations and functions and select, convert flexibly among, and use various representations for them. (NCTM)
- Students will be able to understand the meaning of equivalent forms of expressions, equations, inequalities, and relations. (NCTM)

3. Rationale

   There are many applications of the quadratic formula in real life. For example:
   - Chemists use the quadratic equation very often, to find concentrations in equilibrium reactions.
   - Mechanics in physics, use this formula $X = V_0\, t + \frac{1}{2} a\, t^2$ to find position, time velocity or acceleration of moving objects.

4. Materials

MS PowerPoint
5. Resources
- IGCSE Cambridge International Mathematics (0607) Extended, Haese & Harris Publications, 2009
- Mathematics for the International Student (IB Diploma), Mathematics HL CORE, Haese & Harris Publications, 2012
- http://en.wikipedia.org/wiki/Projectile_motion
- http://www.docstoc.com/docs/151216699/Sample-CT-High-School-Lesson-Plan-_Fall-2010_
6. Getting Ready for the Lesson (Preparation Information)
- Make sure the computer and the projector works before the lesson.
- Write the questions to be solved on a PowerPoint document.
- Prepare name charts for the students.
7. Prior Background Knowledge (Prerequisite Skills)
- Students should have basic algebra knowledge. They should be able to activate their algebraic thinking skills.
- Students should have learned what a quadratic equation is and how to solve quadratic equations by factorization.

Lesson Procedures

Transition: Greeting, self-introduction. (Hello, I'm Ezgi Çallı. I am an MA Student in Bilkent University GSE. Today we are going to make a review session with you for your exam.)

8A. Engage (3 minutes)
- Inform the students that the word "quadratic" comes from the word "*quadratus*" in Latin, which means "square".
- Ask the students if they think that people other than math students and teachers use quadratics in their lives, or not? (**synthesis**)
  After getting their ideas, give information about the projectile motion in sports. Connect quadratics to sports by showing the following photos: golf, basketball, diving, etc. Ask how we can use quadratics to model the motion in the pictures? (**synthesis**)
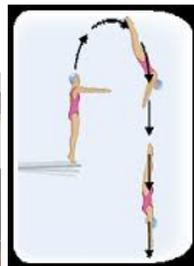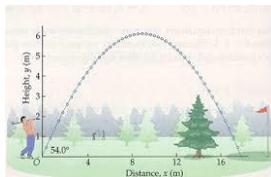
Transition: "You have learned how to factorize quadratic equations when the expression is easily factorable. But life is not always that easy. We should be able to find the solutions when the numbers are large and complicated and the expression does not factor easily. Now let's play with the general quadratic equation to find a general rule of solving it."

B. Explore (10 minutes)

Prepare a worksheet as follows for the students to explore where the quadratic formula comes from. (Proof of the quadratic formula)

$$ax^2 + bx + c = 0$$	Write the general quadratic equation.
$$ax^2 + bx = -c$$	Carry the constant term to the right hand side of the equation
$$\frac{a}{a}x^2 + \frac{b}{a}x = -\frac{c}{a}$$	Divide each term by a
$$x^2 + \frac{b}{a}x + \left(\frac{b}{2a}\right)^2 = -\frac{c}{a} + \left(\frac{b}{2a}\right)^2$$	Complete the left hand side of the equation to a square by adding the necessary terms.
$$\left(x + \frac{b}{2a}\right)^2 = -\frac{4c}{4a} + \frac{b^2}{4a}$$	Equalize the denominators on the right hand side. Express the left hand side as a perfect square.
$$x + \frac{b}{2a} = \pm\sqrt{\frac{b^2 - 4ac}{4a}}$$	Take the square root of both sides.
$$x + \frac{b}{2a} = \pm\frac{\sqrt{b^2 - 4ac}}{2a}$$	Take the denominator of the right hand side outside the square root
$$x = -\frac{b}{2a} \pm \frac{\sqrt{b^2 - 4ac}}{2a}$$	Leave x alone on the left hand side

- Tell them to work with their friend who is sitting nearby.
- Observe and listen to students as they interact. Take personal notes.

Transition: Ask the students how they evaluate the activity. Ask if they are sure about the validity of the quadratic formula, after exploring where it comes from. **(evaluation)**

C. Explain (5 minutes)

- Ask the students what they think about the square root expression in the quadratic formula. What can the values inside the square root

be? (**analysis**)

- Explain when equation will have zero real roots, when it will have one real root and when it will have two real roots.
- Tell the students that things are a bit COMPLEX when b^2 - 4ac < 0, but they are not learning at this stage.

Transition: Now, let's solve some word problems using what we have learned up to this point.

D. Extend (20 minutes)

Reflect the following questions on the board, one by one. Ask the students how to solve the questions by using the quadratic formula (if necessary). (**application**)

Give time for the students to write the questions and think about the questions (3 minutes for each.)

Q1. A rectangular garden measuring 12 meters by 16 meters is to have a pedestrian pathway installed all around it, increasing the total area to 285 square meters. What will be the width of the pathway?

Give information to the students about the validity of the two roots of the equation. A negative root y not work in some contexts in word problem, such as in this question. So, they could consider only the positive root.

Q2. A motorboat makes a round trip on a river 56 miles upstream and 56 miles downstream, maintaining the constant speed 15 miles per hour relative to the water. The entire trip up and back takes 7.5 hours. What is the speed of the current?

Q3. Is it possible to bend a 12 cm length of wire to form the perpendicular sides of a right angled triangle with area a) $13.5cm^2$ b) $20\ cm^2$? If yes, find the length of the perpendicular sides.

(Remind the students how to find the area of a triangle.

After solving with the quadratic formula, ask them how they can use the graphing calculator to observe 3rd question. (**application**)

Ask them to find the roots in part a with the graphing calculator. (**application**)

Ask them how do we interpret no real solution in the graph, in part b? (**analysis**)

Ask them if the graph looks like the pictures related to sports in the engagement part? Why? Why not? (**analysis**)

Transition: We're done with the questions today. Now, I want you to write 2 sentences about…

E. Evaluate (2 minutes)

Monitor the students during the exploration and extension parts. Take notes.

Give a minute paper to them, to write two sentences about what they have learned or what they have not understood.

9. Closure & Relevance for Future Learning (1 minute)

Ask students what did they learn today? Write the keywords on the board. (**evaluation**)

Wrap up saying that it was all for today.

Wish success for their exams.

Say: "I hope you enjoyed the lesson."

10. Specific Key Questions:

The questions and the related taxonomy levels are provided throughout the plan.

11. Modifications

Observe how fast the students solved the questions. Make adjustments for the complexity of the exam questions according to the students' level of understanding.