P3/ GRAD P 1 LESSON TEMPLATE

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School: ___Milton High School_____ Grade: Pre- Calc A (11th and 12th)_

Overview:

Goals: (What is the general purpose of the lesson? What is your overall intent of teaching this lesson?)

The purpose of this lesson is for students to develop an understanding of higher degree polynomial functions and their graphs. In my discovery activity, my aim is for students to discover the pattern for determining the end behavior of higher degree polynomial functions. In the notes afterwards, my aim is to solidify this knowledge and to teach students how to sketch the graphs of these polynomials by finding their zeros. My overall intent in teaching this lesson is to help students relate algebraic representations of polynomial functions to their graphs, as these concepts are extremely important later in pre-calculus and also in calculus.

Massachusetts Standards Covered:
MA Frameworks:
12.G.4: Relate geometric and algebraic representations of lines, simple curves, and conic sections.

AII.P.6: Given algebraic, numeric, and/or graphical representations, recognize functions as polynomial, rational, logarithmic, or exponential. (12. P. 6)

PC.P.2: Relate the number of roots of a polynomial to its degree.

Language Objectives: (How will ELLs use/improve language skills in this lesson? Give an example.)
Students will be able to:

- Demonstrate an understanding of the terms “end behavior”, “leading coefficient” and “highest degree” by identifying them on given polynomials functions
- Demonstrate an understanding of the “leading coefficient test” by using it to discover the end behaviors of polynomial functions
- Recognize that the same process is used to find the x-intercepts of a function as when a problem asks to find the zeros of a function
- Demonstrate an understanding of the term “multiplicity of a zero” by identifying it when given a function.

Specific Instructional Objectives: (What will students be able to do by the end of the lesson?)
Students will be able to:

- Identify the highest degree and leading coefficient of a polynomial function
- Describe the left and right end behavior from a graph
- Discover the properties of the Leading Coefficient Test
- Apply the Leading Coefficient Test to describe the left and right end behavior of a function
- Find the real zeros of a polynomial function algebraically
- Sketch the graph of a polynomial function by finding zeros and using the end behavior.
- Recognize the similarities between zeros, x-intercepts, solutions of $f(x) = 0$, and factors of $f(x)$
- Identify the multiplicity of the zeros of the function

In this Pre-Calculus class, I have a transfer student from Spain who does have some trouble with English language concepts, although he is not formally classified as an ELL student. The strategies in this lesson that will help him are the typed notes handouts as well as the many examples that I give while providing notes. He had expressed to me when we met earlier that examples always help him to decipher what a math question is asking. In addition, writing out short and simple definitions in addition to the long definitions for some of the more complicated terms will assist in his understanding.

Content: (What is the content of the lesson?)

The content of this lesson is most of Chapter 2.2: Graphing Polynomial Functions of Higher Degree. In this lesson, I am specifically covering how to find leading coefficients and highest degrees from polynomial functions, end behavior, the Leading Coefficient Test, finding zeros, and sketching polynomial functions from finding their zeros and end behaviors.

Classroom Environment and Management Conditions: (How you will arrange the classroom, facilitate student learning and minimize disruptions.)

The classroom will be arranged as it normally is with the desks in groups of three or four so that students can work together during the discovery project. As soon as students come in, I will tell them to take out their homework so that I can check it. While I am checking their homework, I will have students pass out the answer sheet so that they can check their answers and come up with any questions they would like to review on the board before we get started with the discovery. This will use time efficiently and minimize disruptions. Before we begin reviewing the homework, I will also post a problem from yesterday's lesson in which a mistake was made and ask students to review the error and see why it was wrong. Finally, I will use the SmartBoard during instruction to write notes and examples as well as the white board if space is needed.

Materials:

- Markers
- Graphing Calculators
- Discovering End Behavior Group Handouts
- "End Behavior Stations" handouts
- Notes Handouts (pre and post discovery)

Diverse Learners

Learner Factors: Differentiation, Modifications, and Accommodations: (What will you do to allow students with different abilities, learning styles, etc. to succeed during the lesson? Check off all that apply)

☐ **Adjust Grouping Formats**	☐ Extend Time of Selected Work	☐ Give More Frequent Breaks
☐ Oral, Pointing, Signed Responses	☐ Reread Directions	☐ **Handout Hard Copy of Board Notes**
☐ Give Additional Examples	☐ Use Assistive Devices to Respond	☐ Word Processor/Computer
☐ **Write Homework List**	☐ **Post visual picture or schedule**	☐ Seating Near Advanced Students
☐ Give Daily Progress Report	☐ Give Verbal Reminders	☐ Use Graphic Organizer
☐ Use of Braille or Large Print	☐ Use of Interpreter	☐ Increase the Number of Review Activities
☐ Give Student Copy of Directions	☐ **Give Verbal Cues to Emphasize Main Ideas**	☐ Pair Students
☐ Provide an Alternate Reading Level for a Reading	☐ Use Page Markers	

Specific Examples: (Choose 3 examples from the list above and elaborate on/explain in detail the accommodation, modification, or differentiation.)

Example 1: Hard Copy of Board Notes: I will provide all students with a printed copy of the notes and examples that I will be writing on the Smartboard with space for them to follow along and fill in notes as I write them on the board. This accommodates students who have difficulties with organization skills, note-taking, and/or focusing. My typed notes will allow students to concentrate on understanding the mathematics concepts rather than copying down long definitions.

Example 2: Adjust Grouping Formats: I previously created these grouping formats with students' diverse ability levels and learning styles in mind, so that the stronger students can scaffold the learning of those who are not as strong in mathematics. During the notes and also discovery activity, students will have a chance to benefit from their peers' help. I believe that collaboration is extremely important in a mathematics class, because students can sometimes explain things differently than a teacher that may make more sense their peers.

Example 3: Post visual picture or schedule: The agenda that I have written on the side board is very helpful for those students who have trouble with organization or listening skills. Providing students with a visual schedule for the day helps students stay focused because they know what to expect. In addition, the visual aspect of this Discovery Activity, involving graphs to visualize end behavior, will cater to the needs of the transfer student from Spain because he learns mathematics concepts better through visualization than written word. This lesson will help him to connect the visual (or graphical) aspect of polynomial functions with the written (algebraic equation).

Procedures:

Opening: (How will you engage and prepare students for the lesson?)
Before students enter, I will have a problem from yesterday on the SmartBoard on which there was an error. As students enter, I will ask students to take out their notes from yesterday and see if they understand why there is an error. Also I will ask students to take out their homework, and in order to save time, I will have one student pass out the answer sheet so students can check to see which problems they have questions on. As students do this, I will come around to check homework. I may have some students put up a homework problem while I finish checking homework, depending on the time. Since this class is smaller, it usually does not take me too long.

During Lesson: (Specific step-by-step details that would allow someone else to teach this lesson. Include specific instructional strategies, methods, student groupings, actions, and questions you will ask.)

**See attached daily schedule and notes sheets for more details. **

1) **Warm Up and Check Homework** *(10 minutes)*
- Introduce Ms. Gormley
- Take out your notes from yesterday and see if you understand the error that was made on the Projectile Motion Problem *(5 minutes)*
- Student explain the error
- Have student pass out homework solutions
- Have student pass back Topics Sheet with my comments (talk about it briefly)?

2) **Review homework questions from Section 2.1** *(10 min)*
- "Look at solutions sheet and see if you have any questions."
- We will do out 1 or 2 problems

4) **Quick Notes- Getting Ready for Discovery on Section 2.2** *(10 minutes)*
- Pass out "Getting Ready for Discovery on Section 2.2" notes handout
- ** This is the PowerPoint that I sent you earlier **
- This is mostly a quick review of some concepts that will prepare students for the "Discovering End Behavior of Polynomial Functions" group activity

5**) Discovery on Section 2.2: End Behavior** *(25 minutes)*
- Students will be split into three groups (I have separate handouts for each group)
- There will be four "End Behavior Stations" on the whiteboard at the back of the room. Four separate pieces of paper will be taped to the whiteboard, each with a separate end-behavior graph.
- (I will set this up before the period begins)
- Students will use the graphing calculators to graph the functions and then record the end behavior on their handouts
- After graphing it on their calculators, they will write out the function and sketch the graphs at the appropriate stations in the back of the room using different color markers.
- Finally, they will look at the graphs and polynomial functions and answer the questions on their discovery handout to make generalizations about the relation of the leading coefficients and highest degree of the functions to their end behavior at each station.
- (End this part **at 8:48 ish)**
- (I will explain this clearly in class)

6) **Notes Wrap Up** *(20 minutes)*
- Pass out notes sheets: wrap up to discovery (once again, you may not be able to open this, but I will send the PowerPoint once I finish redoing it)
- We will review what students discovered about end behavior and pull it all together in an organized manner
- We will continue with the notes on Section 2.2 that the discovery leads into

7) **Pass Back Tests** *(7 minutes)* **(9:11)**
- I will talk about the averages and the grades
- I will review 1 or 2 problems that most students got wrong
- Pass back Topics Sheet and talk about it briefly

8) **Announce Homework and Quiz Next Wednesday on Section 2.1 – 2.3**
- "Make sure you have the homework written out from the side board and that you pick up a Topics Sheet"
- Hw: Topics Sheet for Section 2.1
- Sect. 2.2: pg # _____.

Closing (How will you end the lesson?)
We will be doing notes up until there is about 7 minutes left in the period. At that time, I will stop the notes in order to pass back the students' tests that they took on Monday and quickly reviewing some of the important concepts that I thought students missed or made errors on. I will have a student pass back the Topics Sheet that was meant to help students study for the test. Finally, I will announce the homework, which will be some practice problems from the book on Section 2.2 as well as to create another Topics Sheet for Section 2.1, which will help them study for their Quiz next Wednesday.

Post-Lesson

Assessment: (How will you determine if you and your students have achieved the lesson's objectives?)
Formative Assessments: I will use questioning during the lesson to continually assess students understanding of the content. Sometimes this is difficult because this class does not participate as much since it is first period and they are still tired. However, during the cooperative Discovery Activity, I will be able to walk around and monitor students' progress on drawing the graphs and answering the questions on end behavior. When we review the answers to the discovery activity, I will be able to assess whether students were able to make the appropriate generalizations about end behavior of polynomial functions. Then as we do the notes on section 2.2 to wrap up and extend what they discovered, I will be able to informally assess students' mastery of the content. Finally, when I check the assigned homework tomorrow and review it, I will be able to see which problems students were able to complete successfully and which they are still having trouble with.

Follow-up: (If appropriate, how will you reinforce the learning at a later time or in another activity?)
Tomorrow, we will continue with the notes on Section 2.2, because I do not think that we will get through all of them today. We will continue to practice finding zeros and sketching polynomial functions using end behavior. I will assign more homework problems for practice on all of these concepts and they will also need to use and expand upon these concepts when we start Section 2.3 devoted to finding real zeros of polynomial functions. Finally, they will have a quiz to assess their understanding of these concepts next week.

Reflection:

These questions and prompts are to be used to direct your post-lesson evaluation and critique of yourself.

1. **What did the students learn from this lesson? How do I know the students were actively engaged with the lesson?**
2. **How closely did I follow my lesson plan? Did I have to modify during the lesson? Why?**
3. **Did I address the variety of skills, learning styles and abilities of all of the students? How? *Provide one specific example or a reason why this was not done.***
4. **Were the materials/visuals/aids appropriate? Why? Why not?**
5. **What do I think was the most effective part of the lesson?**
6. **What did I find most challenging about this lesson?**
7. **What do I see as my teaching strengths in this lesson?**
8. **My goal for the next lesson is:**
9. **One way my supervisor or Cooperating Teacher can assist me with attaining my goal is:**