Becoming an NBA Coach to Find the Perfect Shot

I. ASSESSSMENT TASK OVERVIEW & PURPOSE:
In this activity, students will be asked to pretend they are NBA coaches helping three different players achieve the best shooting form. They will then have to create an equation and graph to represent each situation. Students will discover multiple different graphs. Students will discuss and analyze intervals of increasing and decreasing, and also domain and range of the graphs. At the end of the task, students will present their findings to the rest of the class.

II. UNIT AUTHOR:
Brooke Mullins, Eastern Montgomery High School, Montgomery County VA.

III. COURSE:
Algebra II

IV. CONTENT STRAND:
Functions
Equations and Inequalities

V. OBJECTIVES:
The student will be able to:
- Write quadratic equations
- Graphically represent the situation
- Identify intervals of increasing and decreasing
- Identify domain and range

VI. REFERENCE/RESOURCE MATERIALS:
Calculator, Graph paper, Poster Board, Geogebra/other Mathematics Software Programs

VII. PRIMARY ASSESSMENT STRATEGIES:
The task includes an assessment component that performs two functions: (1) for the student it will be a checklist and provide a self-assessment and (2) for the teacher it will be used as a rubric. The assessment list for this activity is intended to evaluate the students' knowledge of defining, analyzing and summarizing the different equations for obtaining the best shot, the graphical representations, intervals of increasing and decreasing, and also domain and range. It will also evaluate the students' group work and final class presentation.

VIII. EVALUATION CRITERIA:
Assessment List for Activity 1, corresponding rubric.

IX. INSTRUCTIONAL TIME:
This Activity is estimated to take 2-90 minute block classes, or 3-45 minute classes.

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Strand
Functions

Mathematical Objective(s)
This activity will address the concept of writing quadratic equations and analyzing graphs. Students will apply their knowledge of domain and range to analyze graphs. Students will also distinguish the intervals of increasing and decreasing. Students will develop skills necessary to represent and evaluate real-world situations graphically.

Related SOL
- AII.7   The student will investigate and analyze functions algebraically and graphically. Key concepts include
  a) domain and range, including limited and discontinuous domains and ranges;
  d) intervals in which a function is increasing or decreasing;

NCTM Standards
- Use representations to model and interpret physical, social, and mathematical phenomena.
- Analyze graphs and distinguish domain/range and intervals of increasing/decreasing.
- Draw reasonable conclusions and summarize a situation being modeled.

Materials/Resources
- Internet
- Graph Paper
- Graphing Calculator
- Instructions Page
- Poster Board
- Mathematics Software Programs

Assumption of Prior Knowledge
- Students should have basic understanding of how to write quadratic equations
- Students should have basic understanding of domain and range
- Students should have basic understanding of intervals of increasing and decreasing
- Students should have basic understanding of paths for projectiles and how to draw the graphs.
- Students should feel comfortable working in groups and drawing graphs to represent the situation.
- Students should feel comfortable speaking in front of the entire class.
- Students may have difficulty finding the different quadratic equations.
- Students may have difficulty drawing a graph to represent the real-world situation.
- Students may have difficulty or feel nervous about speaking in front of the class.
- The relevant context students should have already explored is domain and range, intervals of increasing and decreasing, and graphically representing a situation.

Introduction: Setting Up the Mathematical Task
- In the task, you will investigate how to write quadratic equations and graphically represent real-world situations. To begin, you will be given an instructional page that provides instructions for this task. In your groups, you will discuss the necessary actions that need to be taken to identify the best shooting form for three different players by finding an appropriate equation. You must create an equation for all

three players to ensure they will make the shot every time. These equations will differ based on each person's height and their "sweet spot" shot. After creating the equations, you must identify domain, range, and intervals of increasing/decreasing. Your group will also draw a picture of the graphs of the real-world situation. At the end of the task, your group will draw your graphs on a large poster board. Then, your group will present the poster to the class and discuss how your group came to that conclusion. You will be given roughly two days to gather information and draw a graphical representation. Then you will have roughly one day to present your finding to the class.
- Teacher will invite students to draw upon prior knowledge of domain, range, increasing and decreasing of graphs by allowing a brief discussion of the topic. Also, a warm-up activity will be completed to help students understand how to write quadratic equations, identify domain/range and intervals of increasing/decreasing.
- Teacher will guide students during the task by asking questions such as "What is the shape of the projectile path?" "What equation should you use?" "How high did the ball go?" "When was it going up/down?" "What conjectures can you make from this?" "How will this help them improve their shot?"
- Students will be working in groups. Within their groups, they will brainstorm different ideas to develop the best equation for a perfect shot. They will use cooperative learning and assign duties to each person in the group.
- Representing the findings graphically and identifying domain/range and intervals of increasing/decreasing help students develop necessary skills to be successful on the Algebra II SOL.
- Presenting the posters of their groups' findings will allow students to make their mathematical thinking and understanding public.

Student Exploration
Individual Work
- Students will complete a Warm-Up activity individually that activates prior knowledge of how to write quadratic equations, identify domain/range and intervals of increasing/decreasing.
- Students will also be assigned different duties within groups that they are responsible for individually.

Small Group Work
- Students will work in small groups to accomplish the task of representing a real-world situation graphically.
- Students will create different equations for the three NBA players to ensure a perfect shot each time.
- Students will then draw graphs representing the equations.
- Students will identify domain/range and intervals of increasing/decreasing.
- Finally, students will draw the graphs on poster board to represent the situation and findings.

Whole Class Sharing/Discussion
- Students will present their posters and findings to the entire class.
- Students will question each other's finding to gain a better understanding of different possibilities for finding a solution.

Student/Teacher Actions:
- Students will be working collaboratively in groups to represent different real-world situations and how to identify domain/range and intervals of increasing/decreasing.
- The teacher should be monitoring progress and ensure students are working collaboratively. In addition, the teacher should ask questions to confirm students' understanding.
- One common misconception the students may experience is the height of the player does not affect the shot. They might not understand that a shorter player must shot the ball higher than a tall player.

- In order to address the misconception, the teacher should demonstrate when the ball leaves the person's hand from different heights.
- One way to increase student learning is to incorporate the use of computers for research on the topic. Also, the use of graphing calculators should be check students work.

Monitoring Student Responses
- Students are to communicate their thinking and their new knowledge by drawing and presenting posters to the class
- Students are to communicate with each other by working cooperatively in groups.
- Teacher and/or students are to highlight and clarify the ideas being grappled by answering questions asked by students.
- Teacher is to assist students who have difficulties by providing guidance and further explanations.
- Teacher is to extend the material for students that are ready to move forward and emphasize real-world application.

Summary of the task/activity
- At the end of the task, students will be asked to present their findings to the class. Once all groups have presented, students will be asked to summarize all findings on an exit slip.
- In order to collect evidence of students' knowledge of the content described, posters will be displayed on the classroom walls. These posters will display the equations for the perfect shots of each player, the graphs, the domain/range of each graph, and other helpful information.

Assessment List and Benchmarks

Warm-up Activity:

1. Describe the difference between domain and range.   2pts.
2. How do you determine whether a graph is increasing or decreasing?   2pts.
3. Find the domain and range of $y=x^2+3x+2$. Explain your answer.   4pts.
4. On what interval is that graph increasing? How do you know?   2pts.
5. On what interval is that graph decreasing? How do you know?   2pts.
6. Write a quadratic equation given the roots 15 and 30 and also the vertex (24, 34).   3pts
7. Write a quadratic equation given the points (2,4) (3,9) (10,100).   3pts

Task 1: Describing Real-World Situations Graphically

In your groups, each person will be assigned a job. There are listed below:
- M**anager**- oversees the entire project to ensure accuracy.
- **Coach**- ensures everyone agrees on an answer.
- **Book keeper**- responsible of writing what everyone has agreed on.
- **Editor**- ensures there are no errors, grammatically, graphically, or mathematically.
- **Referee**- ensures everyone is working together peacefully.

Each person in the group must participate and speak in the final presentation. In order to gain full credit, all categories on the rubric must be completed with accuracy. Use the rubric to self-assess to ensure all categories are met with full potential. Highlight the appropriate score you think your group should earn. Be sure to grade yourselves with honesty! This will be a group grade so collaboration is highly encouraged!

At the end of the task, your group must create a poster including the different equations representing each players perfect shot, domain/range, and intervals of increasing/decreasing. In addition, your group must present these findings to the class. You must describe how you began the project, the different ways you could find the equations, and how you identified domain/range along with intervals of increasing/decreasing. In addition, each person in the group must explain some part of the task. Be sure to discuss the domain/range and intervals of increasing and decreasing for each graph. Compare and contrast each graph.

Becoming an NBA Coach to Find the Perfect Shot
Directions: Today you are pretending to be an NBA coach. You must select three different players and help them find their perfect shot form by creating equations for their shots. This equation must allow players to make a perfect shot each time they shoot. Also, you must identify each player's sweet spot location by watching a video of them shooting. Then, you must find the perfect equation for your three different players' "sweet spot" shot and the free-throw shot. This will allow your team to become the best shooting team in the NBA. When you are finished writing your equations, analyze each graph to find domain/range and intervals of increasing/decreasing. Again, use rough estimates. Next, you will draw the graphs on a large poster board. At the end of the task, your group will present their project to the rest of the class.

Player 1: Name?   height: ?   sweet spot: ?

Player 2: Name?   height: ?   sweet spot: ?

Player 3: Name?   height: ?   sweet spot: ?

1. In basketball, the rim stands 10 feet above the ground. The NBA length to the free throw line is 15 feet. You want your players to become perfect with their shots. You need to create an equation to ensure all three players will make a free throw every time they shoot. Write three equations to describe each player's perfect shot. (Use videos of each player's shot to identify points on the graph. You may also want to consider mathematics software programs.)
2. After ensuring your team will make 100% of free throw shots, you now must help your players perfect their sweet spot shots. Using videos of each player, identify their sweet spots and the location from the goal. Then, create three equations for your players perfect sweet spot shot. (You may also want to consider mathematics software programs.)
3. Draw a graph representing all three player's perfect free throw shot and sweet spot shot.
4. On the graphs, identify the domain and range. Compare the free throw line graph to the sweet spot graph for each player. How will the domain/range help you perfect their shots?
5. On the graphs, identify the intervals of increasing and decreasing. Compare the free throw line graph to the sweet spot graph for each player. How will these intervals of increasing/decreasing help you perfect their shots?
6. Compare all graphs using domain and range and also intervals of increasing and decreasing. Note any similarities and differences. Were any the same?
7. Looking at all your graphs, what do you think the free throw shot graph will look like for someone who is 7'5"? Also, where do you think their sweet spot might be located at on the court? How did you come to these conclusions?
8. After checking all work, draw a completed illustrated representation of the situations. Be sure to draw **all** graphs on the poster board. Label the domain and range of the graphs. Also, label the intervals of increasing and decreasing for each graph. Be creative and make the posters eye appealing. Include realistic pictures to

represent the players, goal, and court. You can also use a computer to obtain pictures for your posters. In addition, you can use Geogebra to help with the graphs and for presentations.

#	Element	0	1	2	Self	Teacher
RUBRIC FOR TASK 1						
Group Members:					Assessment Grade	
1	Title and description	No title or description provided	Title and description are incomplete	Title and description provided		
2	Equations for free throw shot for each player	Did not write equation	Wrote less than three different equations	Wrote more than three different equations		
3	Equations for sweet spot shot for each player	Did not write equation	Wrote less than three different equations	Wrote more than three different equations		
4	Free throw line graphs	No rough Free throw line graph	Less than three Free throw line graphs	More than three Free throw line graphs		
5	sweet spot graph	No sweet spot graph	Less than three sweet spot graphs	More than three sweet spot graphs		
6	Domain of Free throw line graphs	No domain labeled on free throw line graphs	Domain labeled but not correctly on free throw line graphs	Domain labeled correctly on free throw line graphs		
7	Domain of sweet spot graphs	No domain labeled on sweet spot graphs	Domain labeled but not correctly on sweet spot graphs	Domain labeled correctly on sweet spot graphs		
8	Range of Free throw line graphs	No range labeled on free throw line graphs	Range labeled but not correctly on free throw line graphs	Range labeled correctly on free throw line graphs		
9	Range of sweet spot graphs	No range labeled on sweet spot graphs	Range labeled but not correctly on sweet spot graphs	Range labeled correctly on sweet spot graphs		
10	Intervals of increasing of Free throw line graphs	No interval of increasing labeled on free throw line graphs	Intervals of increasing labeled but not correctly on free throw line graphs	Intervals of increasing labeled correctly on free throw line graphs		
11	Intervals of increasing of sweet spot graphs	No Intervals of increasing labeled on sweet spot graphs	Intervals of increasing labeled but not correctly on sweet spot graphs	Intervals of increasing labeled correctly on sweet spot graphs		
12	Intervals of decreasing of Free throw line graphs	No interval of decreasing labeled on free throw line graphs	Intervals of decreasing labeled but not correctly on free throw line graphs	Intervals of decreasing labeled correctly on free throw line graphs		

13	Intervals of decreasing of sweet spot graphs	No Intervals of decreasing labeled on sweet spot graphs	Intervals of decreasing labeled but not correctly on sweet spot graphs	Intervals of decreasing labeled correctly on sweet spot graphs		
14	Prediction of Taller player with explanation	No prediction	Incorrect prediction with no explanation	Correct prediction with explanation		
15	The components of the project are organized.	No organization	Some organization	Materials are well-organized when handed in.		
16	Group Duty	Did not complete duty	Completed duty but accurately	Completed duty accurately		
17	Speech	No Speech	Not everyone spoke clearly and understandably	Everyone spoke clearly and was understandable		
18	Presentation of Findings	No presentation	Presented findings but not accurately	Presented findings accurately		
TOTAL POINTS EARNED					/36	/36

Sample Student Work:
Becoming an NBA Coach to Find the Perfect Shot

Directions: Today you are pretending to be an NBA coach. You must select three different players and help them find their perfect shot form by creating equations for their shots. This equation must allow players to make a perfect shot each time they shoot. Also, you must identify each player's sweet spot location by watching a video of them shooting. Then, you must find the perfect equation for your three different players' "sweet spot" shot and the free-throw shot. This will allow your team to become the best shooting team in the NBA. When you are finished writing your equations, analyze each graph to find domain/range and intervals of increasing/decreasing. Again, use rough estimates. Next, you will draw the graphs on a large poster board. At the end of the task, your group will present their project to the rest of the class.

Player 1: Shaquille O'Neil   height: 7'1"   sweet spot: center shot 7' from goal

Player 2: Kobe Bryant   height: 6'6"   sweet spot: three pointers 23'9" from goal

Player 3: Allen Iverson   height: 6'0"   sweet spot: three pointer from corner 22" from goal

1. In basketball, the rim stands 10 feet above the ground. The NBA length to the free throw line is 15 feet. You want your players to become perfect with their shots. You need to create an equation to ensure all three players will make a free throw every time they shoot. Write three equations to describe each player's perfect shot. (Use videos of each player's shot to identify points on the graph. You may also want to consider mathematics software programs.)
Shaq: Using the graphing calculator I used a scatterplot to get my equation. For my three points I used (0, 7.083), (15,10) and then I used a shooting video to find my other point of (7,15). This gave me $y=-0.1171x^2+1.9505x+7.083$

   Kobe: Using the graphing calculator I used a scatterplot to get my equation. For my three points I used (0, 6.5), (15,10) and then I used a shooting video to find my other point of (7,15). This gave me $y=-0.12262x^2+2.07262x+6.5$

   Allen: Using the graphing calculator I used a scatterplot to get my equation. For my three points I used (0, 6), (15,10) and then I used a shooting video to find my other point of (7,15). This gave me $y=-0.12738x^2+2.17738x+6$

2. After ensuring your team will be 100% from the free throw line, you now must help your players perfect their sweet spot shots. Using videos of each player, identify their sweet spots and the location from the goal. Then, create three equations for your players perfect sweet spot shot. (You may also want to consider mathematics software programs.)
*Shaq: Using the graphing calculator I used a scatterplot to get my equation. For my three points I used (0, 7.083), (7,10) and then I used a shooting video to find my other point of (3.5,15). This gave me $y=-0.5272x^2+4.10729x+7.083$*

   Kobe: Using the graphing calculator I used a scatterplot to get my equation. For my three points I used (0, 6.5), (23.75,10) and then I used a shooting video to find my other point of (11.875,15). This gave me $y=-0.04787x^2+1.28421 x+6.5$
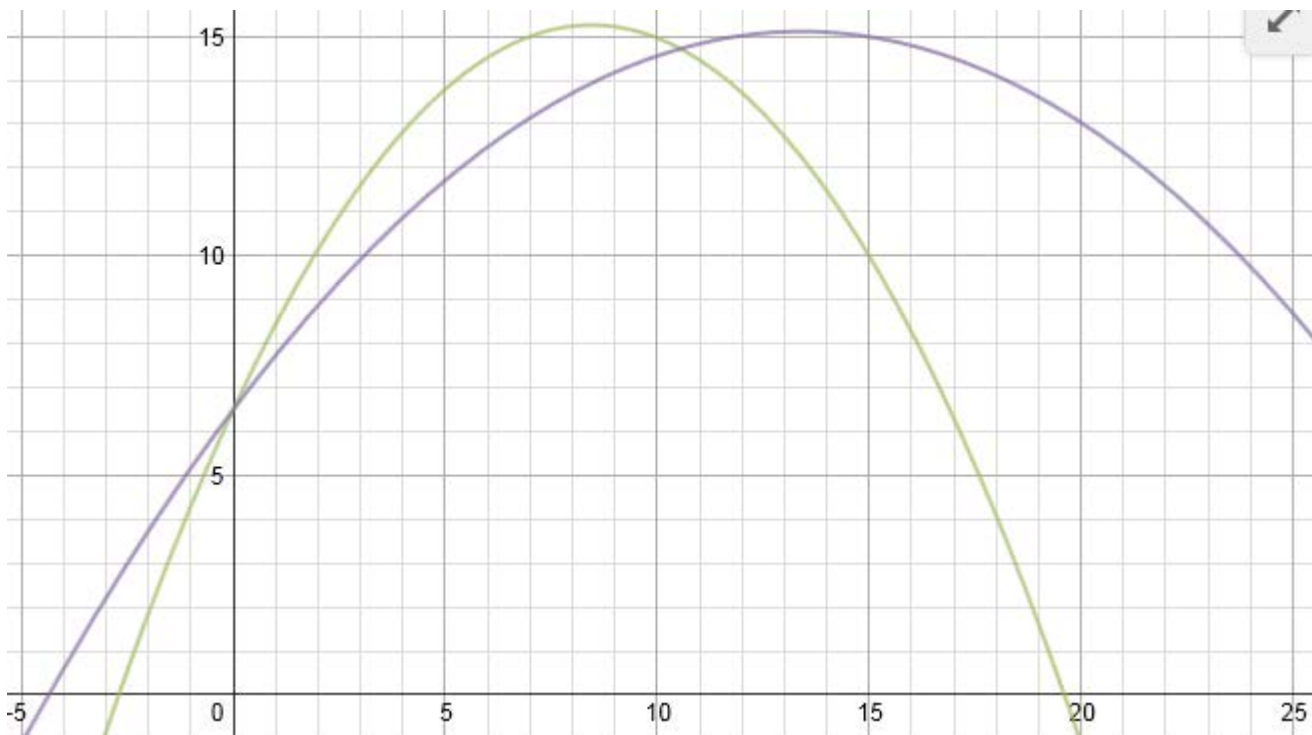
Allen: Using the graphing calculator I used a scatterplot to get my equation. For my three points I used (0, 6), (22,10) and then I used a shooting video to find my other point of (11,15). This gave me y=-0.05785x²+1.45455x+6

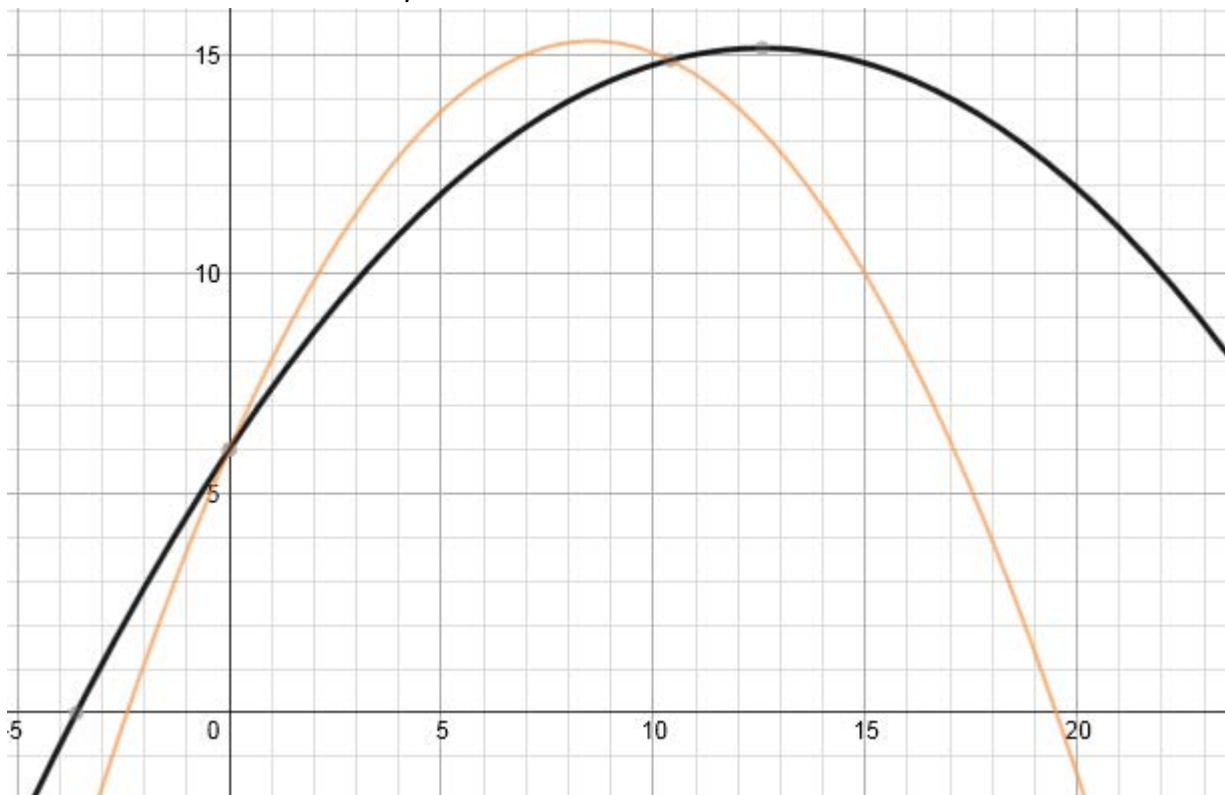3. Draw a graph representing all three player's perfect free throw shot and sweet spot shot.
   Shaq Free Throw and Sweet Spot:
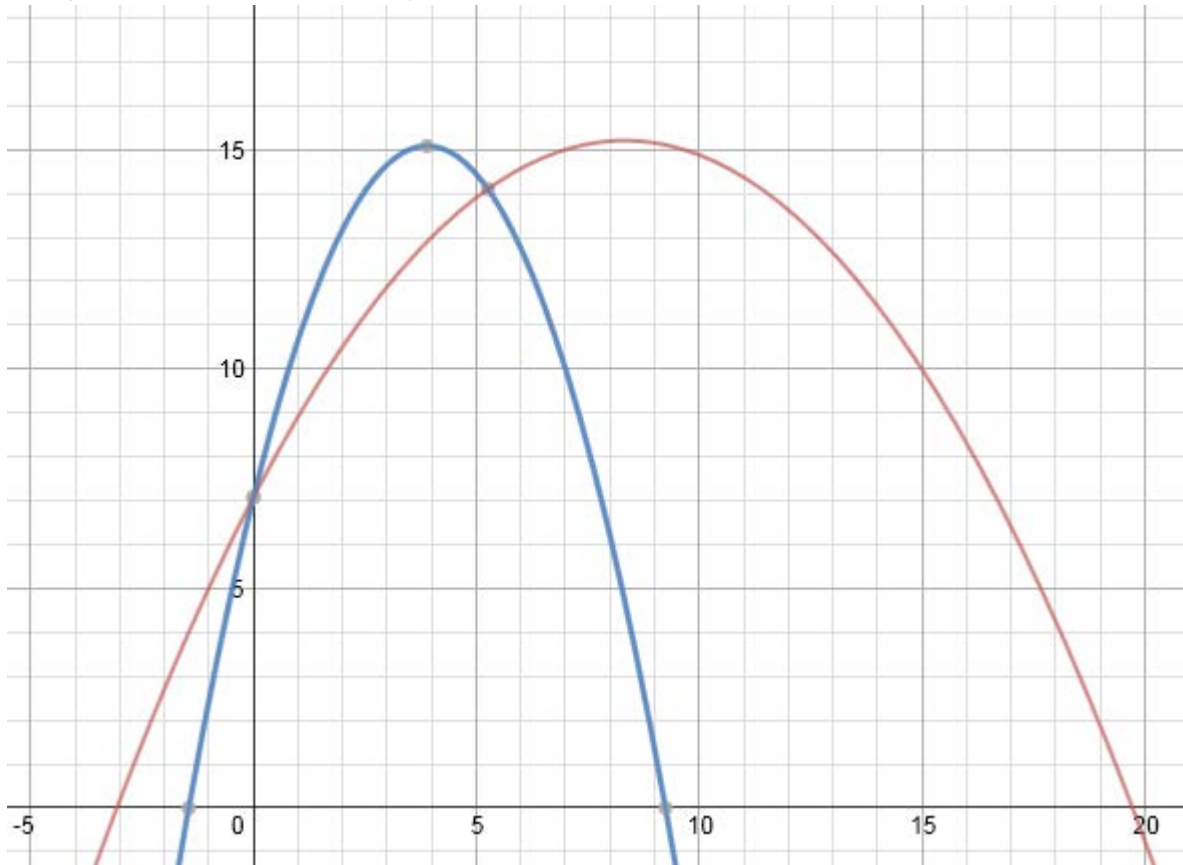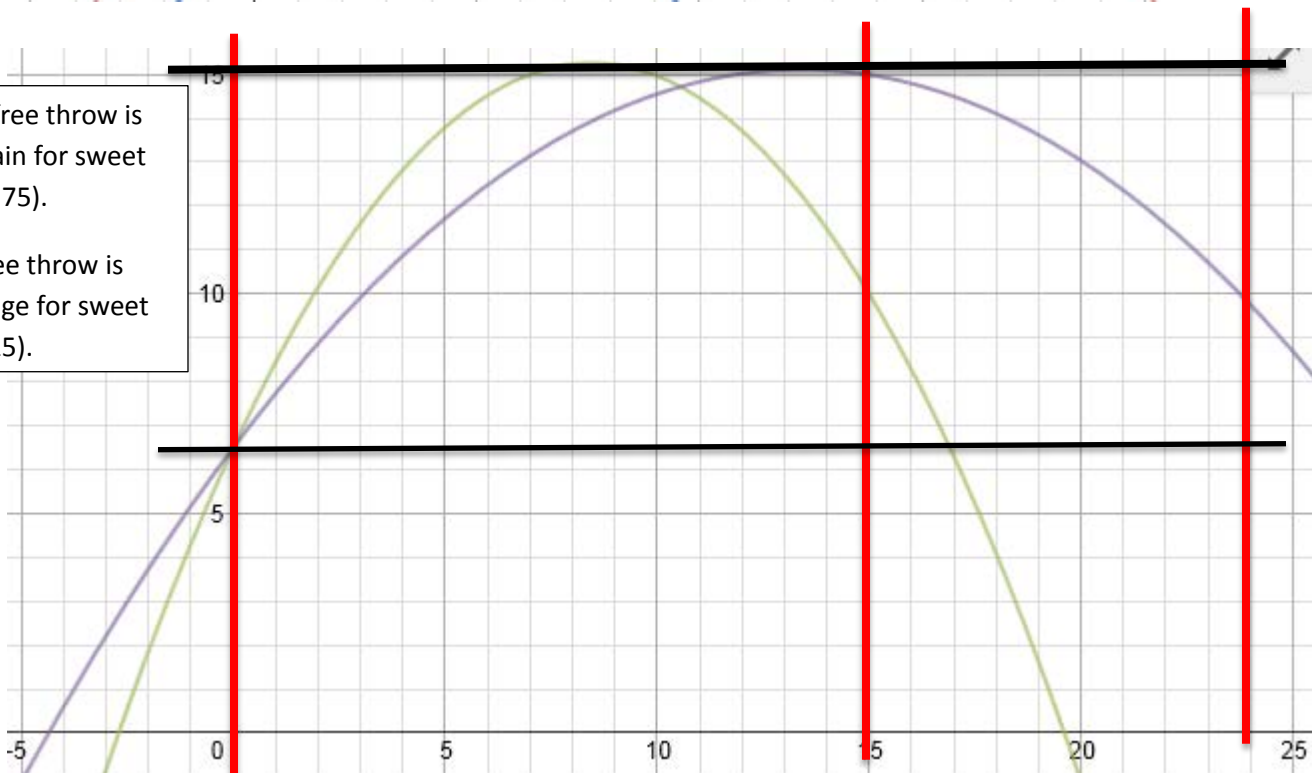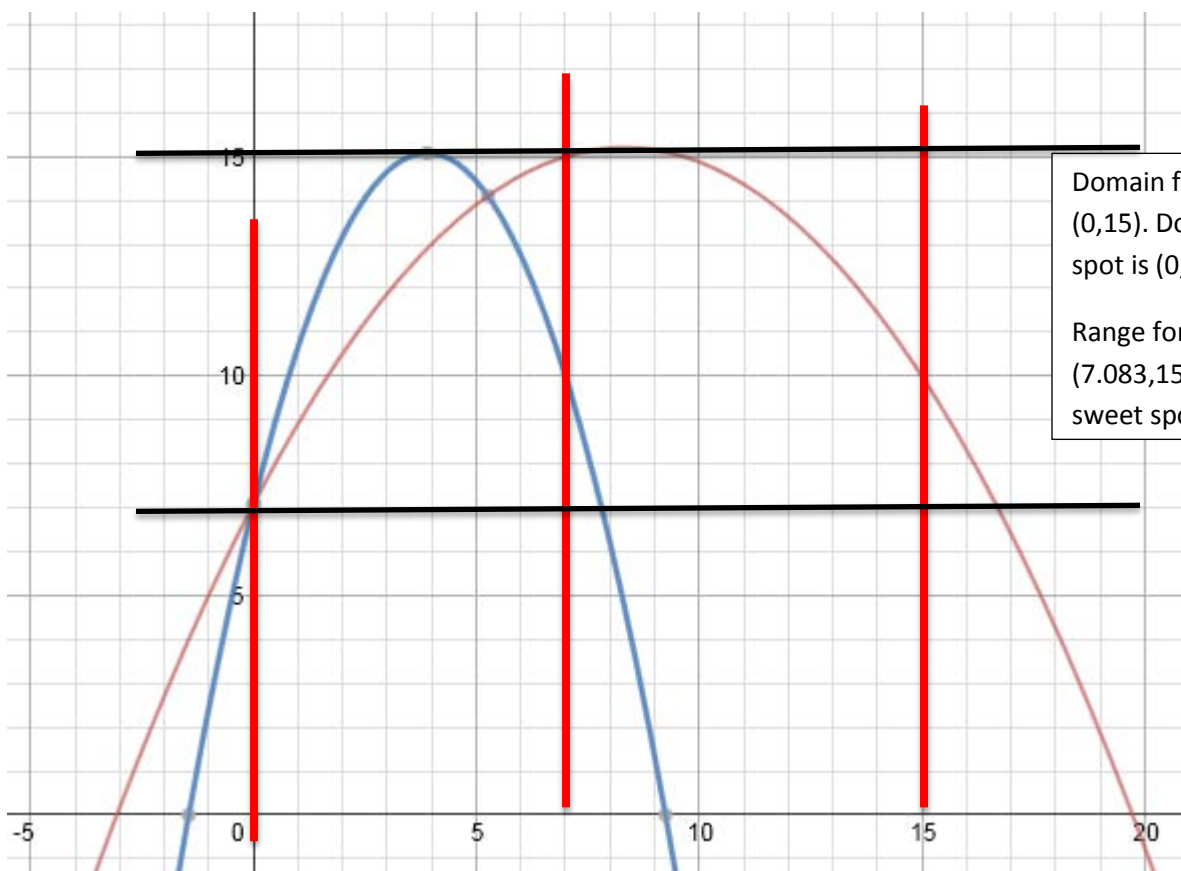

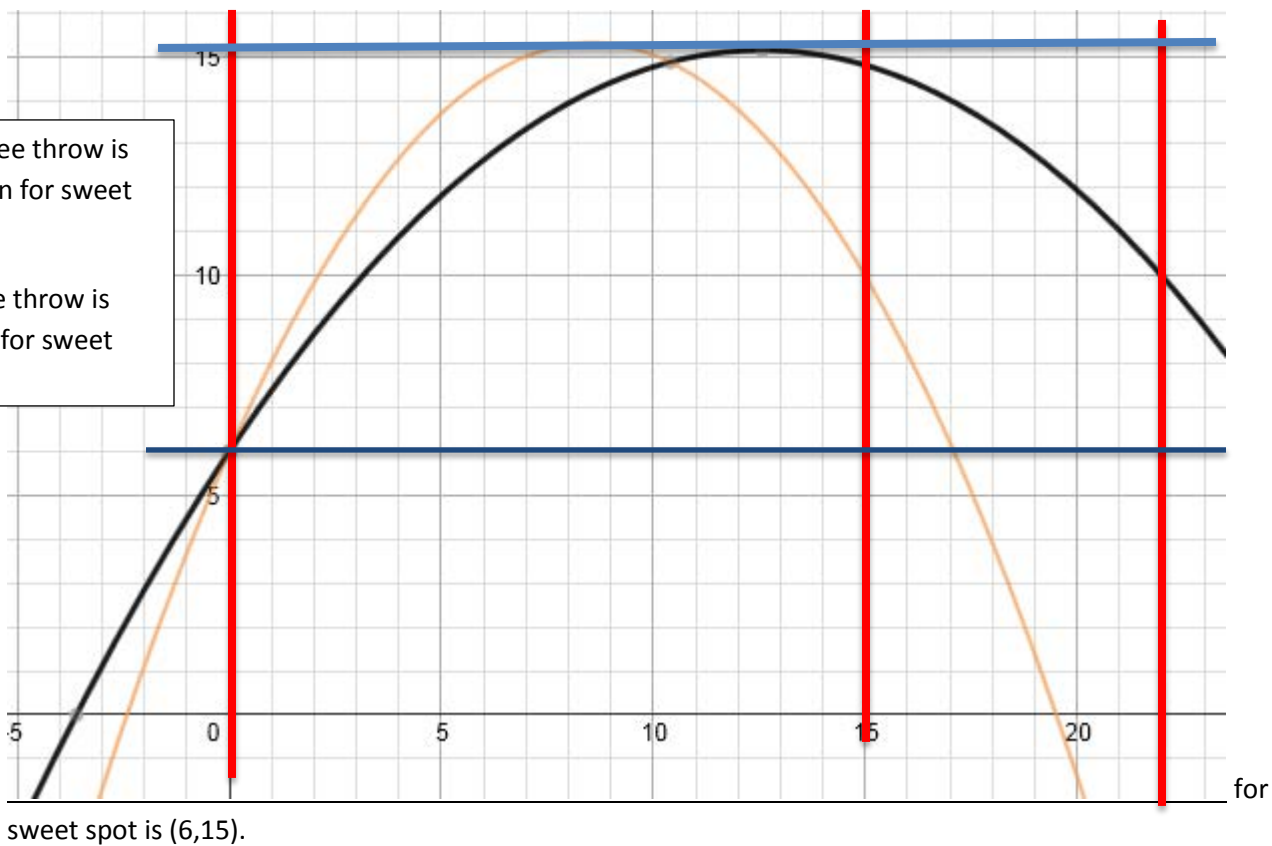
Kobe Free Throw and Sweet Spot:

9

Allen Free Throw and Sweet Spot:

4. On the graphs, identify the domain and range. Compare the free throw line graph to the sweet spot graph for each player. How will the domain/range help you perfect their shots?
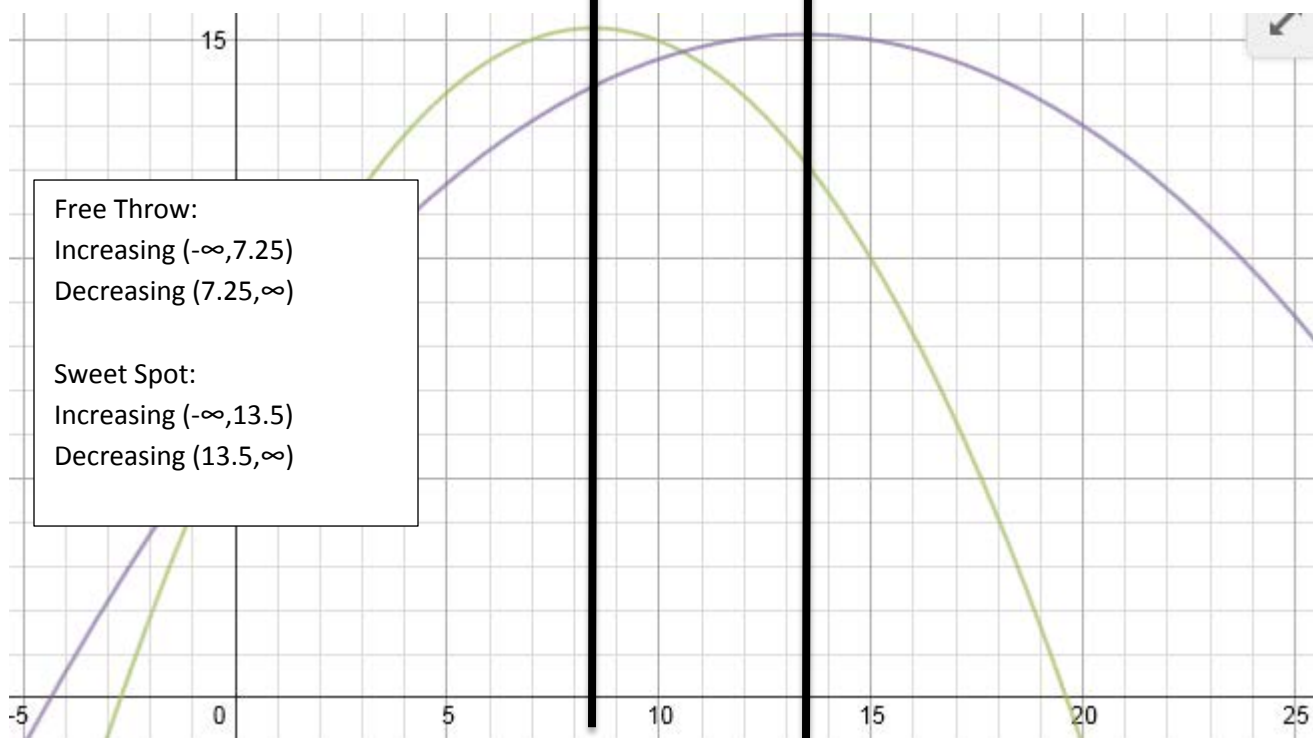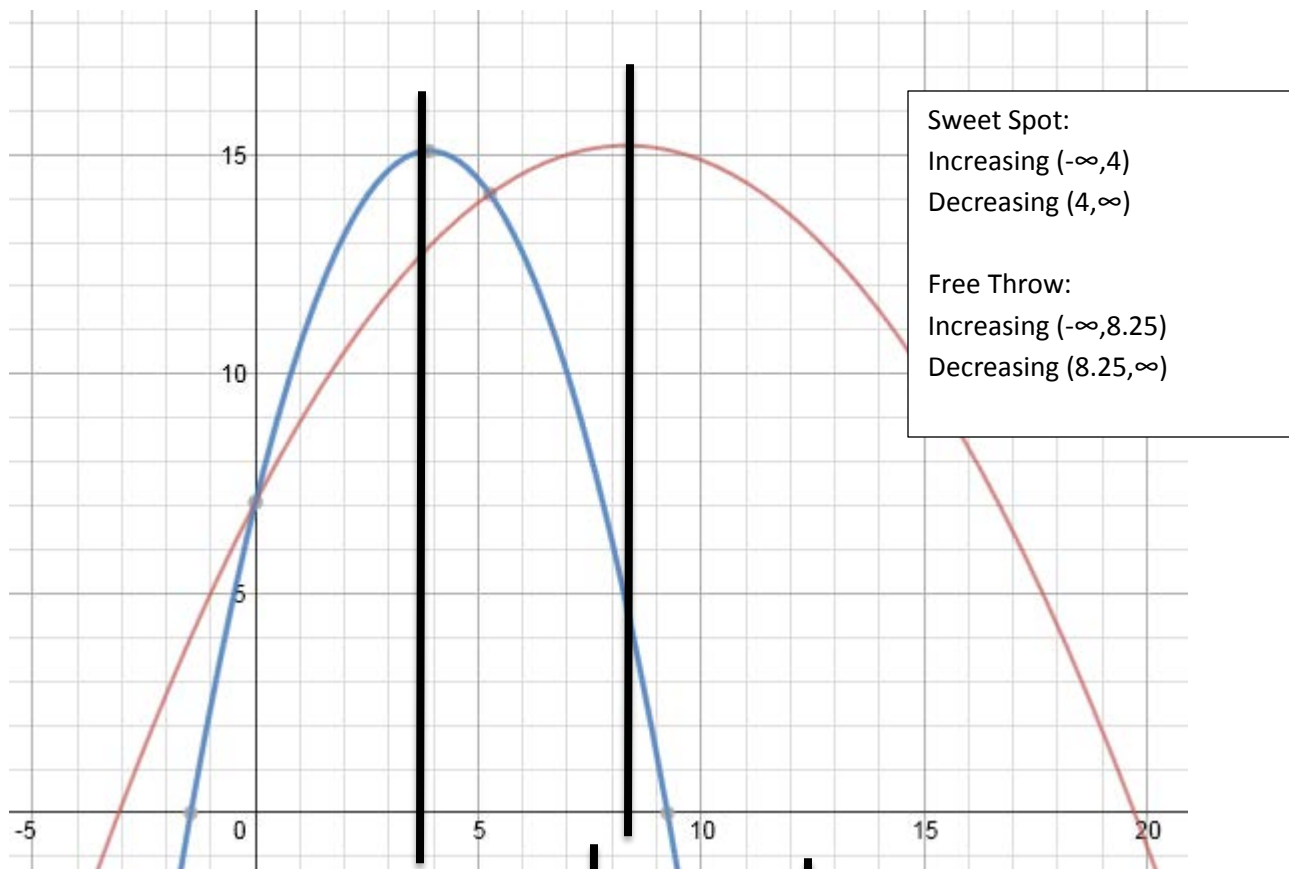   The domain will tell me how far out the player can make a shot. For example, it can tell me if the player will be able to make a shot farther back behind the free throw line or their sweet spot. The range can help me determine how high a player needs to shoot in order for it not to be blocked. For example, a shot needs to be at least 15 feet high for another player not to block it.

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Domain for free throw is (0,15). Domain for sweet spot is (0,7).

Range for free throw is (7.083,15). Range for sweet spot is (7.083,15).

Domain for free throw is (0,15). Domain for sweet spot is (0,23.75).

Range for free throw is (6.5,15). Range for sweet spot is (6.5,15).

Domain for free throw is (0,15). Domain for sweet spot is (0,22).

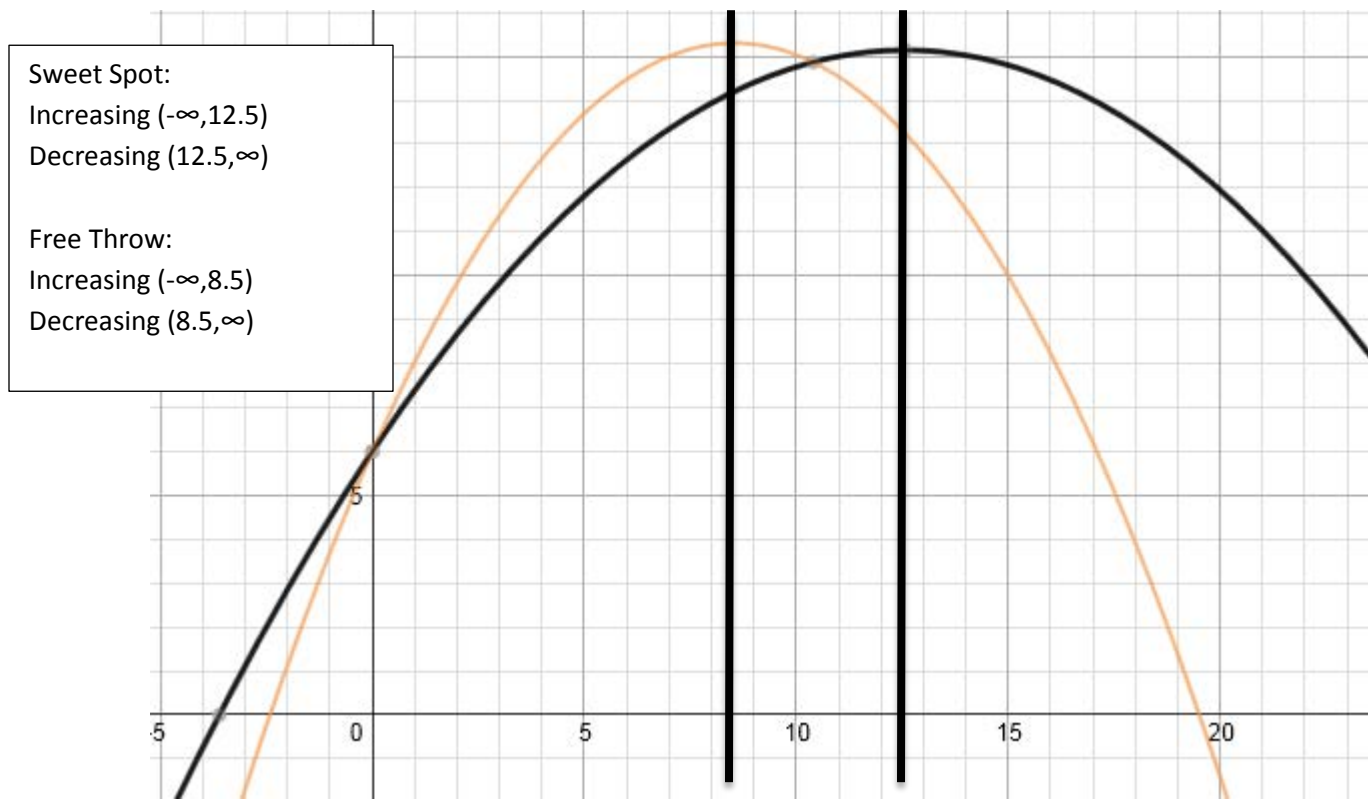Range for free throw is (6,15). Range for sweet spot is (6,15).

sweet spot is (6,15).

5. On the graphs, identify the intervals of increasing and decreasing. Compare the free throw line graph to the sweet spot graph for each player. How will these intervals of increasing/decreasing help you perfect their shots?

The intervals of increasing and decreasing can help me as a coach determine if a player needs to put more power into a shot and also put more arc on the ball. Furthermore, the intervals can help me determine if a player needs to shoot the ball higher so another player cannot block it. For example, a player cannot block a shot as it is coming down to the rim; this is called goal tending. Thus, the player needs to ensure the ball does decrease on its way to the goal to prevent goal tending.

Sweet Spot:
Increasing (-∞,4)
Decreasing (4,∞)

Free Throw:
Increasing (-∞,8.25)
Decreasing (8.25,∞)

Free Throw:
Increasing (-∞,7.25)
Decreasing (7.25,∞)

Sweet Spot:
Increasing (-∞,13.5)
Decreasing (13.5,∞)

Sweet Spot:
Increasing (-∞,12.5)
Decreasing (12.5,∞)

Free Throw:
Increasing (-∞,8.5)
Decreasing (8.5,∞)

6. Compare all graphs using domain and range and also intervals of increasing and decreasing. Note any similarities and differences. Were any the same?
   All of the free throw graphs have the same domain and range. This is due to the same distance from the goal and also my selection of the vertex of each parabola. Also, most of the free throw shot are increasing and decreasing on the same intervals. All the sweet spot shots are different because of the distance from the goal.

7. Looking at all your graphs, what do you think the free throw shot graph will look like for someone who is 7'5"? Also, where do you think their sweet spot might be located at on the court? How did you come to these conclusions?
   I think the graph will look similar to Shaq's graph but with a gentler slope. When comparing the graphs, you can see that as a player gets taller, the slope of the graph becomes less steep. This is because the player is taller and does not have to shoot it higher in the air. I also think his sweet spot will be close to the goal like Shaq's. Since he is a tall player, he will more than likely play post position. This means he will shoot most of his shots close to the goal, about 7'. However, again this slope will not be as steep as Shaq's because he will be taller.

8. After checking all work, draw a completed illustrated representation of the situations. Be sure to draw **all** graphs on the poster board. Label the domain and range of the graphs. Also, label the intervals of increasing and decreasing for each graph. Be creative and make the posters eye appealing. Include realistic pictures to represent the players, goal, and court. You can also use a computer to obtain pictures for your posters. In addition, you can use Geogebra to help with the graphs and for presentations.