Transforming sports with Geometry

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This curriculum unit is recommended for:
Mathematics/ Geometry/ Common Core Math II/ Grade 9, 10

Keywords: Transformations, translations, reflections, rotations, dilatation, composition of translations, soccer.

Teaching Standards: See Appendix 1 for teaching standards addressed in this unit.

Synopsis:

Being a high school teacher is not an easy job these days, you always need to keep up with the new technologies, new apps that help you create a great learning environment and the big amount of information that our students are surrounded by. Our mission as teachers is to prepare highly qualified individuals for the 21st century, ready for the working field, prepared to manage all the requirements for the job they're applying. What a better way to do that than teaching Math using sports.
Soccer is one of the most popular game in the world and there is a great industry around soccer, starting with the players and coaches, clubs' administrative team and manager and ending with the fans. That's why I chose to incorporate soccer in my unit about transformations, since the game is all about movement in the coordinate plane represented by the soccer field (translations, rotations, reflections, dilations).

I plan to teach this unit during the coming year to 68 students in Common Core Math II/ Grade 9, 10

Rationale

Being a high school teacher is not an easy job these days, you always need to keep up with the new technologies. There are new apps that help you create a great learning environment. There are also large amounts of information surrounding our students, which inherently affects our teaching. Our mission as teachers is to prepare highly qualified individuals for the 21st century, ready for the working field and prepared to manage all the requirements for the jobs to which they are applying. What a better way to do that than teaching Math using sports?

Objectives

The new Common Core State Standards[1] expect that high school students who are enrolled in Common Core Math II class will be able to represent transformations in the plane using, e.g., transparencies and geometry software, describe transformations as functions that take points in the plane as inputs and give other points as outputs, and compare transformations that preserve distance and angle to those that do not (e.g., translation versus horizontal stretch). Given a geometric figure and a rotation, reflection, or translation, they are expected to be able to draw the transformed figure using, e.g., graph paper, tracing paper, or geometry software and specify a sequence of transformations that will carry a given figure onto another. Students will be able to verify experimentally the properties of dilations given by a center and a scale factor: a dilation takes a line not passing through the center of the dilation to a parallel line, and leaves a line passing through the center unchanged. The dilation of a line segment is longer or shorter in the ratio given by the scale factor.

Many people enjoy sports, whether it is football, basketball, soccer, golf, tennis, softball, skating, gymnastics or swimming. According to International Business Times[2], "over 108 million Americans watched the Baltimore Ravens beat the San Francisco 49ers 34-31 in Super Bowl XLVII. The game comes in third on the list of most-watched television events in U.S. history. Last year's Super Bowl between the New York Giants and New England Patriots set a record with 111.3 million viewers. That barely eclipsed the 111 million viewers for the 2011 Super Bowl." Such enthusiasm for sports isn't restricted to football. "Turner Sports and CBS Sports' coverage of the 2013 NCAA® Division I Men's Basketball Final Four® on CBS on Saturday, April 6, earned an average fast national household rating/share of 9.4/18, up 4% from last year's 9.0/17, and is the highest-rated Final Four in eight years (10.5/19 in 2005), based on Nielsen Fast Nationals. The 2013 Final Four averaged 15,702,000 total viewers, up 3% from last year's 15,256,000 total viewers, which is the highest viewership average for the two Final Four games since 2005 (16,647,000 for Illinois/Louisville and North Carolina/Michigan State). Worldsoccertalk.com claims that The 2010 World Cup Final set a new record for the most watched soccer game in U.S. history Sunday when 24.3 million people watched the Spain versus Netherlands game on ABC and Univision, according to Nielsen. The 2010 World Cup set another record in the United States by being the most-viewed World

Cup ever on English-language TV. The 64-match World Cup averaged a 2.1 U.S. rating and 3.261 million viewers on ESPN, ESPN2 and ABC, up 31% in ratings and 41% in viewership from 2006 (1.6, 2.316 mil). Average viewing numbers for Univision are not yet available, but in comparison to viewing audiences for other sports, ESPN averaged 4.596 million viewers for the 2010 NBA Playoffs (ABC averaged 10.970 million for its 16-game coverage), and 4.311 million for its coverage of 2009-10 college football bowl games (ABC averaged 22.179 million for its three games). Wiki.answers.com says that 1/5 US Americans tune in to watch consistent golf on promontory 26 different channels every week weather a recording saved or preferably the pros"

Having all this data in mind, I chose to use soccer as a great trigger for my lessons. Since I teach Common Core Math II Honors and IB MYP (a new course of study that blends concepts from Algebra I, Algebra II and Geometry), I think that talking about UEFA Champions League and FIFA World Cup would be a great way to increase cultural and global awareness of my students and to deepen the area of interaction Health and Social education which deals with physical, social and emotional health and intelligence—key aspects of development leading to complete and healthy lives[3].

Any soccer team's head coach has certain strategies to train his/her players. These strategies can be the key to winning a game. Starting with the soccer field, we see mathematics and geometry. The field is rectangular in shape. Geometry is also in the game in how the players align and how they play form other shapes as they play. Within this aspect of the game are geometric ideas like angles and triangles. What would happen if the angle that player A passes the ball to player B changes by 2 degrees? Would it be a winning strategy to have 3 players forming an equilateral triangle or isosceles triangle? What if the goalkeeper moved the line of defense closer to the goal area by 1ft?

Andre Botelho is a recognized authority in the subject of youth soccer coaching and is known online as the "Expert Youth Soccer Coach"[4]. He has helped thousands of youth soccer coaches and parents improve their coaching skills. He's the author of the widely used "Youth Soccer Coaching Manifesto" report and free soccer coaching books like "The Expert Youth Soccer Coaching Guide", downloaded for more than 100,000 times. Andre Botelho influences well over 15,000 youth soccer coaches from more than 25 countries a year with his unique soccer coaching philosophies and strategies. In " Killer Soccer Formations, Positions & Strategies," he sustains that "the secret of a perfect recipe lies in using the right ingredients. Similarly, in soccer, a successful outcome is only possible when you use the right soccer formation. There are numerous soccer formations from which to choose. However, 4-4-2 is the most commonly used soccer formation in modern soccer games. In this system, there are four defenders, four midfielders, and two forwards/centers. Compared with other formations, this is the most versatile, thereby making way for numerous variations." One of the greatest strengths of this system is its defense-midfield interaction, offering a strategic blend of offensive attacks and solid defense. The goal is a well-balanced approach. Given this, teams worldwide have adapted the formation in order for it to better fit their overall playing strategies. As such, many teams have their own version of the formation. Below, we see the standard formation for a 4-4-2.

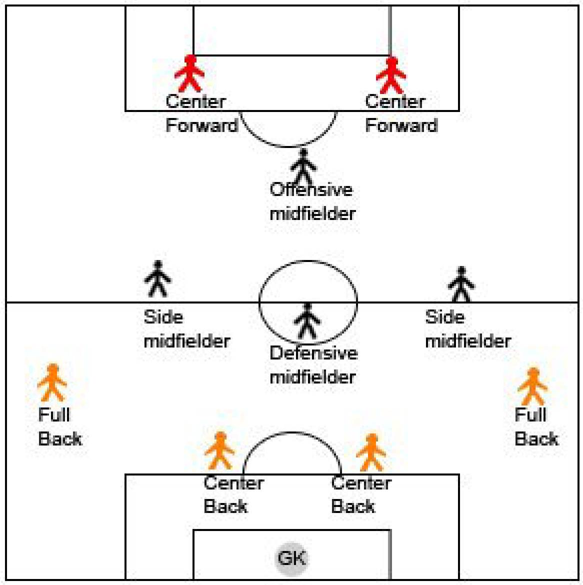
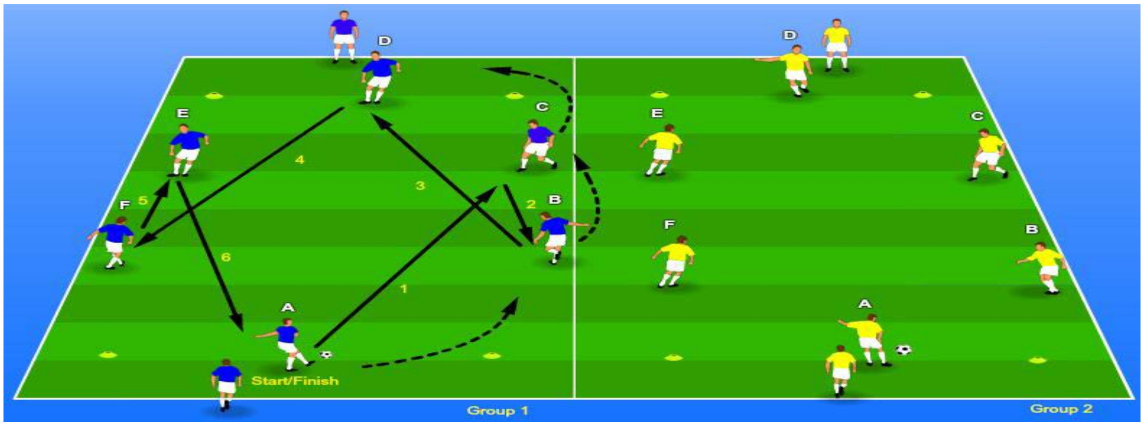


Diagram of the 4-4-2 formation

Training plays an important role in creating a winning. As such, coaches develop their personal blend of exercises and drills for practice. NSCAA suggests that a training exercise recommended for groups between U-10 and U-18 is Rectangle Passing Combination Sequence[5]. For this drill, two rectangles are formed with 8-9 players in each group. This is a dynamic activity with quick passing and sharp movement support off the ball. The sequence is as follows: Sequence Part 1: A passes to C, C passes back to B (one touch), and B passes to D. A moves up to take B spot, B to C spot, and C spins out and joins back of line D. Sequence Part 2: D passes to F, F passes back to E (one touch), E passes to opposite line A and the sequence starts again. D moves up to take E spot, E takes F spot, and F spins out to join back of line A. The drill is played as a competition in which multiple games are played. Each game lasts approximately 2 minutes. Each group is challenged to complete as many sequences as possible. The team that completes the most sequences wins.(WDM Soccer Club |Copyright © Gareth-Smith-WDMSC| Coaching Department - Revised 2010)



Many aspects of playing soccer involve geometry. Again, there is the rectangular field, the angle that a player chooses to shoot the ball, triangular shapes made by two players and the goalie as a defensive strategy, and even the rectangular area that a goalie has to cover in order to defense the goal. Coaches often analyze many of these aspects in preparing for another team. They look at game tape to see what strategies another coach and the team is playing.

For instance, one might analyze the use of tiki-taka by team Barcelona[6]. Tiki-taka is a style of play in soccer characterized by short passing and movement, working the ball through various channels, and maintaining possession[7].The style is primarily associated with La Liga club FC Barcelona from Johan Cruyff's tenure as manager to the present, and the Spanish national team under managers Luis Aragonés and Vicente del Bosque. The roots of what later would become known as tiki-taka lay in the style of play propagated and implemented by Johan Cruyff during his tenure as manager of Barcelona from 1988 to 1996. It continued to develop under Barcelona's Dutch coaches Louis van Gaal and Frank Rijkaard and was subsequently adopted by other La Liga teams. Tiki-taka moves away from the traditional thinking of formations in soccer to a concept derived from zonal play. Tiki-taka is above all, a systems approach to soccer founded upon team unity and a comprehensive understanding in the geometry of space on a soccer field. Tiki-taka has been variously described as a style of play based on making your way to the back of the net through short passing and movement, a short passing style in which the ball is worked carefully through various channels, and a nonsensical phrase that has come to mean short passing, patience and possession above all else. The style involves roaming movement and positional interchange amongst midfielders, moving the ball in intricate patterns and sharp, one or two-touch passing. Tiki-taka is both defensive and offensive in equal measure – the team is always in possession, so doesn't need to switch between defending and attacking. Commentators have contrasted tiki-taka with route one physicality and with the higher-tempo passing of Arsène Wenger's 2007–08 Arsenal side, which employed Cesc Fàbregas as the only channel between defense and attack. Tiki-taka is associated with flair, creativity, and touch, but can also be taken to a "slow, directionless extreme" that sacrifices effectiveness for aesthetics.

To look at soccer play as geometry, we need to look at how to transform a soccer field into a 2D plane we see in a geometry classroom. First, each player on the soccer field becomes a point on the plane. Two individuals become the endpoints of a segment. We begin to see how the number of available strategies increases with the number of players by looking at the number of players (points) and possible line segments between them. As the number of players increases, the number of possible line segments also increases. The number of possible ways to pass the ball between two players equals the number of 2 player combinations that can be arranged from the total number of players. This equals ${}_nC_2$, where n is the number of players. If there are 3 players, there are only 3 ways to pass the ball between 2 players. If there are 4 players, the possibilities increase to 6, which equals ${}_4C_2$ and with 5 players, there are 10 ways, which equals ${}_5C_2$.

Keep in mind that this isn't the only way to look at players and their place on the field geometrically. Every 3 players create a triangle, 4 players will create 2 triangles, and 5 players will create 3 triangles. Note that the numbers of triangles will always equal with the number of players minus two.

Creating triangles is an important part of playing the tiki-taka. Ideally more than one triangle is formed. For example, when 3 players are making an attack, we have seen there are 3 ways for the ball to be passed between 2 players. Notice what happens if a midfielder creates another triangle. First, we know have 4 -2 or 2 triangles. But, now we also have increased to 6 ways to pass the ball between two players. By adding 1 player and consequently 1 triangle, we have also doubled the number of passing options between two players. This is why Barcelona players quickly come to support the ball on an offensive attack. Again, why? This can be emphasized with students. As you increase the number of players, you increase the number of passing options.

Often the forward on a soccer team, Lionel Messi for FC Barcelona, plays an important role in the offensive and shooting opportunities. Suppose Messi receives the ball. Quickly, six other players come to support him. Suddenly, the offense goes from one sole player advancing the ball to a strategy that involves 5 triangles and ${}_7C_2=21$ ways to pass the ball between them. Remember that soccer is played at a fast pace. So, Messi has a small amount of time to decide and make the right choice to whom pass the ball. Often, he will make a good choice, which is why he is considered one of the best players in the world[8].

To get a sense of this visually, the picture below shows Messi and the other players. Notice the triangles formed by the players and the choices he has for passing.

Given the picture above, students be asked the following questions:

1. What types of angles can you identify in the picture? What relationships can you determine between them? Explain
2. What types of triangles do you see in the picture? Classify them by sides and by angles.
3. Label each vertex of each triangle. Given A, B, C, D, E, F, G, investigate what are the conditions for triangles to be congruent? What about for them to be similar? Explain.
4. Considering that the circled player is Messi, analyze what would be his best option to pick a teammate to pass the ball. What information would you use to rank the importance of each player at this point in the soccer match? Explain your reasoning.

Teaching strategies

The main topic of the unit will be related to the transformations in the coordinate plane. According to the Common Core State Standards, students are expected to understand that transformations and symmetry are used to analyze real-world situations. One real-world situation is the game of soccer. After introducing my students to the basic concepts of transformations (translations, reflection, rotation and dilation) they will go in more depth analyzing how these transformations are used in a soccer game. I will start the unit by teaching my students what a translation is and how to perform translations in the coordinate plane.

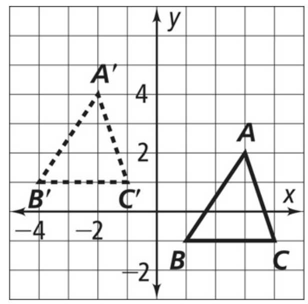
Lesson plans and classroom activities

The unit will be composed by 5-6 lessons, and each lesson is a block period long consisting of 75 to 90 minutes. Each lesson will have an individual lesson plan, which is aligned to the Common Core State Standards.

Lesson1

A translation is a transformation that maps all points of a figure the same distance in the same direction. In a translation, a geometric figure changes position, but does not change shape or size. The original figure is called the *pre-image* and the figure following transformation is the *image.*

The diagram at the right shows a translation in the coordinate plane. The pre-image is ΔABC. The image is $\Delta\, A'\, B'\, C'$.

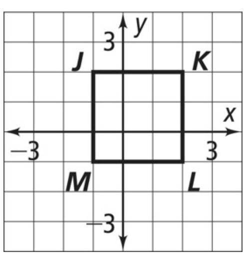


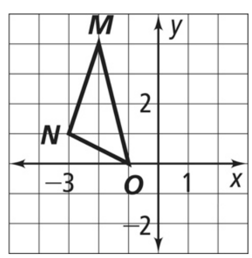
Each point of ΔABC has moved 5 units left and 2 units up. Moving left is in the negative x direction, and moving up is in the positive y direction. So, the rule for the translation is $(x, y) \rightarrow (x - 5,\ y + 2)$.All translations are *isometries* because the image and the pre-image are congruent. In this case, $\Delta ABC \cong \Delta\, A'\, B'\, C'$.

For practicing the rules of translations, students will have to perform different translations in the coordinate plane, using either algebraic rules or wording rules. First they will need to complete the following exercises:

Use the rule to find the images of the vertices for the translation.

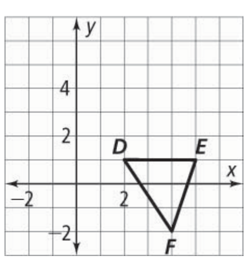
1. ΔMNO $(x, y) \rightarrow (x + 2, y - 3)$**2.** square $JKLM$ $(x, y) \rightarrow (x - 1, y)$

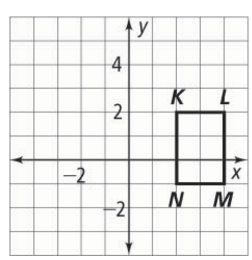




Graph the image of each figure under the given translation.

3. 5 units left, 3 units up **4.** 2 units left, 4 units down





Rewrite the rule of translations (from algebraic to wording or vice versa)

5. 3 units left, 2 units down

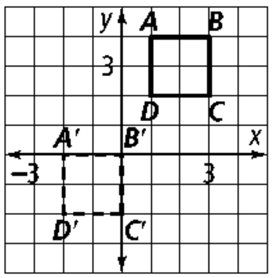
6. 1 unit up

7. $(x, y) \rightarrow (x-1, y+4)$

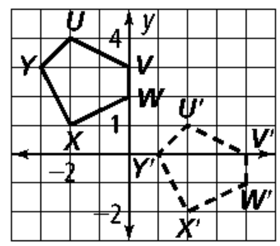
8. $(x, y) \rightarrow (x+3, y+3)$

The dashed-line figure is a translation image of the solid-line figure. Write a rule to describe each translation.

9.



10.

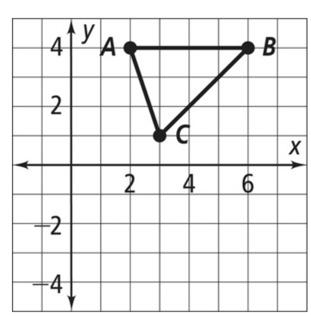


After practicing these types of problems, students will be exposed to the concept of the composition of transformations. A composition of transformations is a combination of two or more transformations. In a composition, you perform each transformation on the image of the preceding transformation. A relevant example is the passes between three players on a hockey field. First player can pass the ball directly to the third player or the ball can be passed from the first player to the second player who passes the ball to the third player. A composition of two translations is another translation.

Lesson2

The second type of transformation is reflection in which a geometric figure is flipped over a line of reflection. In a reflection, a pre-image and an image have opposite orientations, but are the same shape and size. Because the pre-image and image are congruent, a reflection is an isometry. To graph a reflection image on a coordinate plane, graph the images of each vertex. Each vertex in the image must be the same distance from the line of reflection as the corresponding vertex in the pre-image. For reflection across the *x*-axis the rule is $(x, y) \rightarrow (x, -y)$. The *x*-coordinate does not change and the *y*-coordinate tells the distance from the *x*-axis. For reflection across the *y*-axis the rule is $(x, y) \rightarrow (-x, y)$. The *y*-coordinate does not change and the *x*-coordinate tells the distance from the *y*-axis. For reflection across the line $y=x$ is the rule is $(x, y) \rightarrow (y, x)$. For reflection across the origin the rule is $(x, y) \rightarrow (-x, -y)$. To understand this type of transformation students will have to complete these exercises:

1.ΔABC has vertices at $A(2,4)$, $B(6,4)$, and $C(3, 1)$. What is the image of ΔABC reflected over the *x*-axis.



Each figure is reflected across the line indicated. Find the coordinates of the vertices for each image.

2.Δ*FGH* with vertices *F*(−1, 3), *G*(−5, 1), and *H*(−3, 5) reflected across *y*–axis

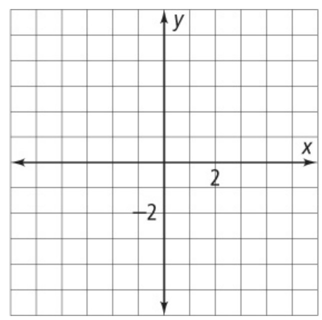
3.Δ*CDE* with vertices *C*(2, 4), *D*(5, 2), and *E*(6, 3) reflected across the origin

4. Δ*JKL* with vertices *J*(−1, −5), *K*(−2, −3), and *L*(−4, −6) reflected across the line *y*=*x*.

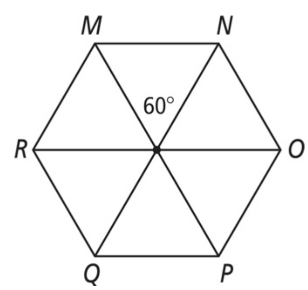
Lesson3

The third type of transformation is rotation. A turning of a geometric figure about a point is a *rotation.* The *center of rotation* is the point about which the figure is turned. The number of degrees the figure turns is the *angle of rotation.* If not otherwise specified, any rotation is performed counterclockwise. A rotation is an isometry. The image and pre-image are congruent. A *composition of rotations* is two or more rotations in combination. If the center of rotation is the same, the measures for the angles of rotation can be added to find the total rotation of the combination. In the coordinate plane, rotations are usually performed around the origin. The rules for rotation are as follows: for a rotation of 90° clockwise the rule is (x, y) → (y, -x); for a rotation of 180° clockwise the rule is (x, y) → (-x, -y); for a rotation of 270° clockwise the rule is (x, y) → (-y, x).

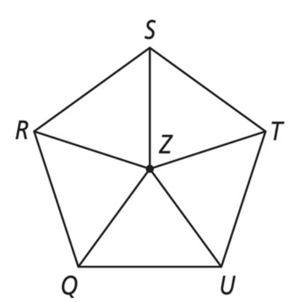
Students will have to complete the following problem. Graph *A*(5, 2). Graph *B*, the image of *A* for a 90° rotation about the origin *O*. Graph *C*, the image of *A* for a 180° rotation about *O*. Graph *D*, the image of *A* for a 270° rotation about *O*. What type of quadrilateral is *ABCD?* Explain. The figure looks like a square. How can you prove it is a square?



Rotations can also be performed on regular polygons. In a regular polygon, the center is the same distance from every vertex. Regular polygons can be divided into a number of congruent triangles. The number of triangles is the same as the number of sides of the polygon. The measure of each central angle (formed by one vertex, the center, and an adjacent vertex) is equal to 360° divided by the number of sides. For example in regular hexagon *MNOPQR*, the center and the vertices can be used to divide the hexagon into six congruent triangles. The measure of each central angle is $\frac{360°}{6}$, or 60°. The image of point M after a 120° rotation about the center of the hexagon is Q.



In regular pentagon QRSTU, what is the image of point Q for a rotation of 144° about point Z? Find the image of the given point or segment for the given rotation: a)216° rotation of S about Z; b)144° rotation of $\overline{TU}$ about Z; c) 360° rotation of Q about Z; d) 288° rotation of R about Z; e)What is the measure of the angle of rotation that maps T onto U?; f) What is the



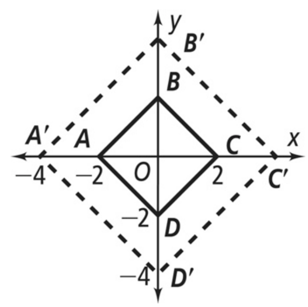
measure of the angle of rotation for the regular hexagon ABCDEF that maps A onto C?;g) What is the measure of the angle of rotation for the regular octagon DEFGHIJK that maps F onto K?

Lesson4

The fourth type of transformation is dilation. A *dilation* is a transformation in which a figure changes size. The pre-image and image of a dilation are similar. The scale factor of the dilation is the same as the scale factor of these similar figures. To find the scale factor, determine the ratio of lengths of corresponding sides. If the scale factor of a dilation is greater than 1, the dilation is an *enlargement*. If it is less than 1, the dilation is a *reduction*.

When dilation are performed in the coordinate plane, the center of dilation is usually the origin. An example of dilation at the origin is the following:

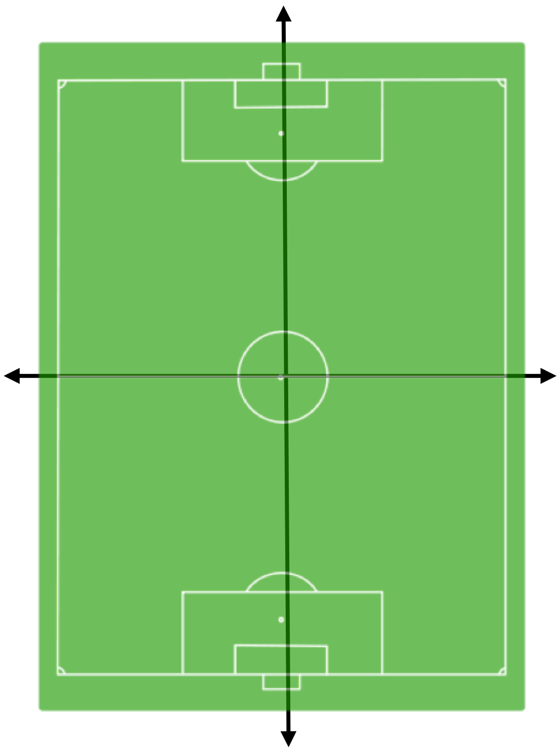
Quadrilateral *ABCD* has vertices *A*(–2, 0), *B*(0, 2), *C*(2, 0), and *D*(0, −2). The image of *ABCD* under the dilation centered at the origin
with scale factor 2 is *A'B'C'D'*. To find the image of the vertices of *ABCD*, we multiply the *x*-coordinates and *y*-coordinates by 2.
A(–2, 0) → *A′*(–4, 0) *B*(0, 2) →*B′*(0, 4) *C*(2, 0) →*C′*(4, 0)
D(0, –2) →*D′*(0, –4)

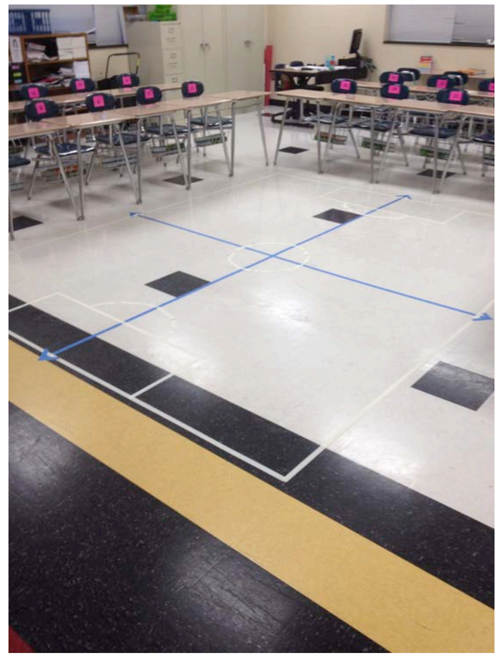


Lesson5-6

In the last two lessons of the unit, students will have to apply all they have learned to the real life situation of a soccer field. Given the image below, they will analyze a F.C. Barcelona game. Students will be divided in three groups that will be chosen at random by picking a colored note. Each group will be given a color name: green team, orange team and pink team. The classroom desks will be arranged in U shape and in the center on the floor there will be a soccer field created with tape. A picture of the classroom follows. Each student will receive a worksheet with instructions.

During practice for the European League, F.C. Barcelona chief coach, Gerardo 'Tata' Martino, will train his team using coordinate Geometry. He will consider the midfield line to be the x-axis of the coordinate plane and the line that passes through the midpoint of each goal to be the y-axis. The center of the soccer field is considered the origin of the coordinate plane. One of the strategies that Tata uses is have to his players in a formation of 3where they change their position on the soccer field using a specific rule.





#1. When practice begins, chief coach tells Messi that he has to be at (-15, -20). Plot Messi's location on the diagram of the field. How would you explain to Messi where he starts the practice in terms of his position on the soccer field?

#2. Another player, Piqué, is told that he has to be located 5 unit right and 7 unit up in reference to Messi's position. Plot Piqué's location on the diagram of the field. What are the coordinates for Piqué's starting position?

#3. The third player in the formation is and he is asked to start 3 unit left 2 down in reference to Piqué's position. Plot Affelay's location on the diagram of the field. What are the coordinates for Affelay's starting position?

#4. Once the three players formation is established, Messi, Piqué and Affelay have to advance to the opposite team area in order to score. The shape of the formation has to be preserved as it moves down the field. The assistant coach tells them that they are performing a translation. Write a definition for the term translation in your own words.

#5**.** Messi's new location is (11, 18). Plot Messi's new position.

The notation for a translation is:(x, y) --> (x + a, y + b)where a represents the change in the x-coordinates and b represents the change in the y-coordinates. Use transformation notation to represent the translation that Messi performed.

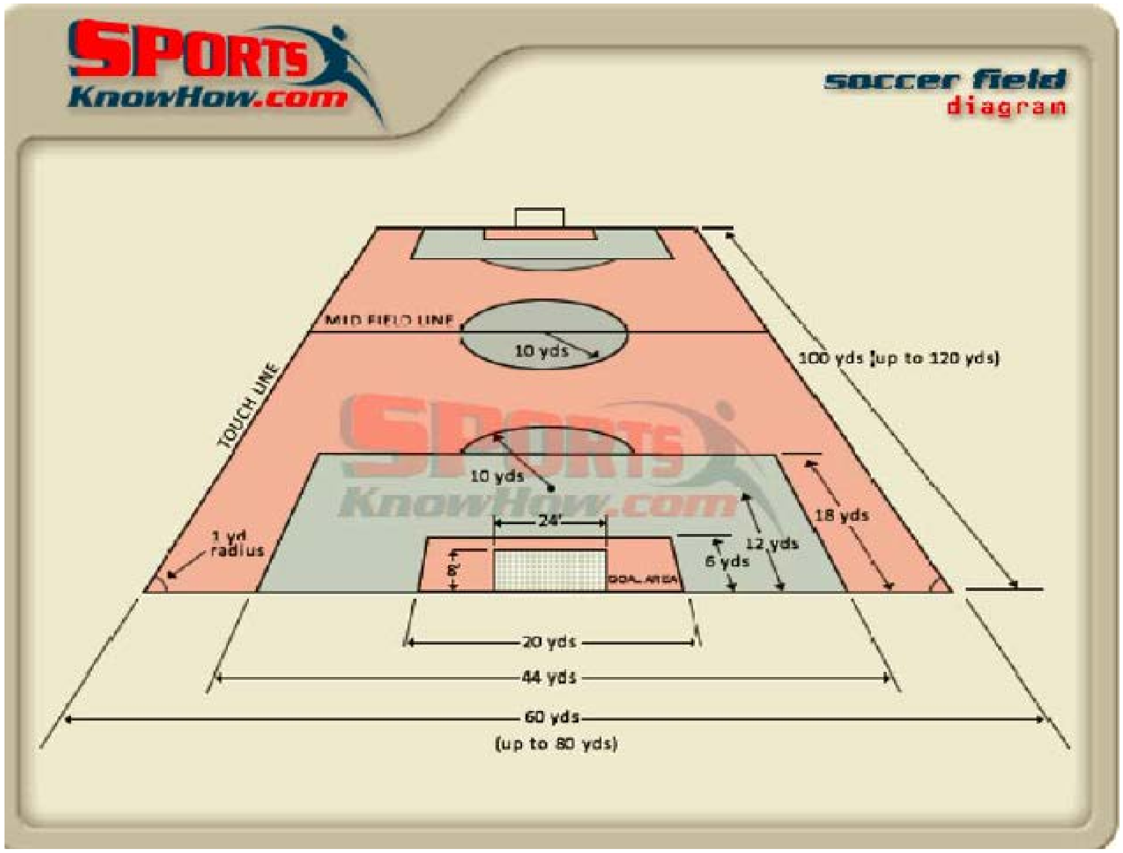
#6. What are Piqué’s and Affelay’s new locations? How can you determine their new positions? Plot their new positions.

#7. When they enter the opponent’s side of the field, they pass the ball within the formation. The movement of the ball can also be seen as a translation of that point. Suppose Messi passes the ball to Piqué, who passes it to Affelay. Determine the translation rule for each pass. Then determine the rule for composition of translation if Messi passes the ball directly to Affelay.

#8. In order to avoid one opponent, Messi changes his location by performing a reflection over the y-axis. Assume Piqué’s and Affelay’s perform the same reflection. What are all three players new positions? Plot the locations on the diagram.

After they complete items #1- #8, students need to choose a captain of their team and 2 assistants. They will plot each location on the big coordinate plane on the classroom floor. After they plotted the points, each group will need to have a presenter (other than the captain and assistants). The presenter will describe the game strategy for the other groups.

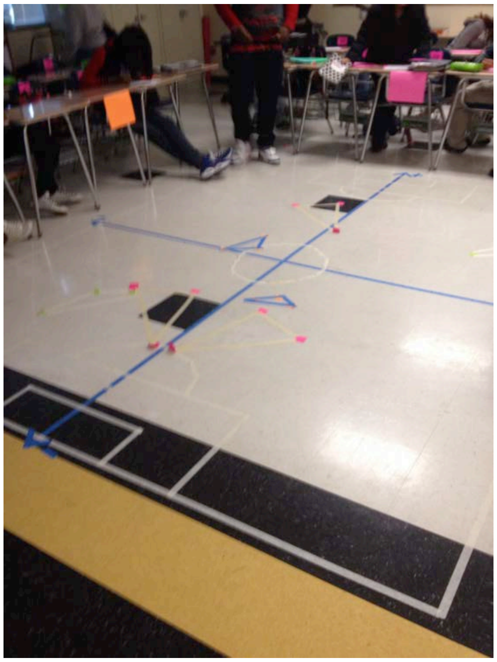
Each soccer team has a strategic plan put in place when they are playing on their home field. Coaches know the length and the width of the field and plan on how they will layout each player during the game. After many hours of practice, the players know where they should be at a specific time to form the desired formation (triangle) in order to have the ball in possession and score. They need to maintain the exact triangle when they move from their part of the field to the opposite side. Each strategy works every time on their home field. But, they will also play away games. Field length and width vary. According to sportsknowhow.com[9] the overall dimensions of a regulation soccer field is 100 yards long and 60 yards wide. The midfield line divides the middle of the field lengthwise. In the center of the field a 10-yard circle marks the area where defenders must stay outside of at the start of a kickoff. A rectangular box (sometimes called the "penalty box") centered on the goal marks the penalty area. This box is 44 yards wide by 18 yards deep. It includes an arc 10 yards from the "penalty mark". Fouls committed in this area may result in a penalty kick. The penalty mark inside the "penalty area" is 12 yards from the end line. The penalty mark is where "penalty kicks" are placed. The goal area is a smaller rectangle inside the "penalty area", centered on the goal. The measurements of this box are 20 yards wide by 6 yards deep. This box marks the area from which a goal kick must be placed. A one-yard quarter circle is marked on each corner of the field to mark where a player must place the ball prior to a corner kick. The adult soccer goal is 24 feet wide by 8 feet high.

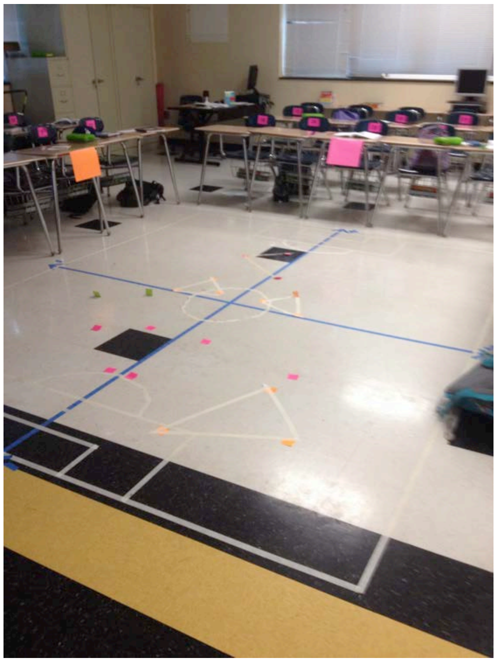


There are very few fixed dimensions for soccer fields[10], even at the highest level. The sport's world governing body, FIFA, only stipulates that for professional 11-versus-11 competition, they must be between 100 yards and 130 yards and the width between 50 and 100 yards. For years, English fields were known to be on the smaller side, making the game more physical while fields in South American stadiums tend to sprawl out and offer players more space and time on the ball. Still, some elements remain constant on full-size fields throughout the world. Therefore, players have to adapt their game related to the size of the field. Having in mind that their basic formation is a triangle that slides along the field, this movement can be interpret as a dilation in the coordinate plane. If F.C. Barcelona has to play a game at Manchester's home, they will need to "shrink' their strategy to fit the smaller size of the field. If they play at Brazil's home field, they will have to enlarge their strategies due to larger size of the field. This means that the geometric transformation performed to the 3 players formation is a dilation.

Let's consider the previous problem in this context: point A represents Messi's position, point B represents Gerard Piqué's position and point C represent Afellay's position. These are the coordinates of each point A(2,-3), B(4, -6) and C(9,-10). They are first playing on a 100yds by 60yds soccer field in London and next day they are playing on a 120yds by 72yds in Brazil. What transformation they need to apply to their game strategies? Explain your reasoning. What is the scale factor and how can you determine? What are the new coordinates for Messi's, Piqué and Affelay?

Finally, I include 2 pictures for reference of the classroom floor as it evolved within my implementation of this unit.





Appendix 1: Implementing Common Core Standards

According to the new Common Core Standards students enrolled in high school Geometry course are expected to begin to formalize their geometry experiences from elementary and middle school, using more precise definitions and developing careful proofs. The concepts of congruence, similarity, and symmetry can be understood from the perspective of geometric transformation. Fundamental are the rigid motions: translations, rotations, reflections, and combinations of these, all of which are here assumed to preserve distance and angles (and therefore shapes generally). Reflections and rotations each explain a particular type of symmetry, and the symmetries of an object offer insight into its attributes—as when the reflective symmetry of an isosceles triangle assures that its base angles are congruent. One domain of CCS is Congruence (G-CO) and two of its standards are to represent transformations in the plane using. (G-CO. A2) and, given a geometric figure and a rotation, reflection, or translation, to draw the transformed figure (G-CO. A5)

In order to implement these standards, I decided to write this curriculum unit that concentrates around Transformations (translations, reflections, rotations and dilations) and how they can be applied in real life problems. Focusing on what my students are interested in and then brought math into their world I will engage my students using soccer through activities that develop critical thinking skills.

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Reading list for students

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"Soccer 101: The Field." About.com World Soccer. http://worldsoccer.about.com/od/soccer101/a/101_Field.htm (accessed October 18, 2013)

List of Materials for Classroom Use

Construction paper
Tape
Sticky notes
Rulers
Markers