

Chapter 7

I'm Hair to Help: A Problem-Based Project on Philanthropy and Linear Equations

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I'm Hair to Help: Philanthropy and Linear Equations

This chapter is written from the perspective of the first author, Mrs. Julie Evans, who was one of approximately forty secondary mathematics teachers from a rural county in a Midwestern state participating in professional development funded by a three-year Mathematics Science Partnership (MSP) grant. The other authors served as two of the facilitators of the professional development. Mrs. Evans reflects upon and discusses the successes and challenges encountered as she and three of her colleagues designed a unit on linear functions and as she implemented that unit with her Algebra 1 students. Mrs. Evans' story is written below in italics. Her story is punctuated with pauses where the authors link what was happening in Mrs. Evans' classroom to benchmark concepts in mathematics education and/or project-based learning (PBL) research.

Each year, before the creation of this unit, I started the chapter on linear functions hoping that my students would retain the concepts taught in the chapter and be able to apply them as we moved into deeper concepts in Algebra 1. Each year, I was disappointed. I felt like a total failure. I thought that I was doing everything I could possibly do to make my students successful; so why did they not remember how to write an equation once we moved on to systems? It seems so obvious now, but at the time, I didn't realize that they were only learning procedures by rote. They didn't have a true understanding of what they were doing or why those procedures worked. They didn't truly understand what the y-intercept and the slope represented, so they were unable to apply those concepts to real world problems.

As part of an MSP grant, teachers from across my county got together for a week-long professional development workshop focused on teaching and learning mathematics for understanding. In the previous year of the grant, we had learned about project-based learning (PBL) and created a unit the summer before. Three other Algebra 1 teachers and I got together

and decided to design a unit on linear functions. We chose linear functions as the topic because our students always struggle with problems on standardized tests that require them to write linear functions for different contexts. We immediately started searching popular PBL sites for ideas to get us started and were intrigued by a unit, called "Locks of Love," featured on www.mathalicious.com. We liked the humanitarian aspects of this unit and decided to use it as a launch for our own unit.

Standards Addressed

According to the Common Core Standards for Mathematics, the work on functions in high school builds on semi-formal notions of function in Grade 8 so that high school students begin to use formal notation and language for functions (Common Core Standards Writing Team, 2013, March 1). The first three groups of high school function standards were addressed in this unit, namely: Interpreting Functions (HSF.IF), Building Functions (HSF.BF), and Linear, Quadratic and Exponential Models (HSF.LE). Some number, algebra, and statistics standards, as well as some mathematical practices were also addressed.

In this unit students were challenged to determine how long it would take them to grow their hair long enough to donate it to a non-profit organization and benefit someone suffering from long-term medical hair loss. They researched the regulations on donating their hair to the organization, as well as average hair growth rates. While different groups of students used slightly different approaches to tackle this problem, students calculated and interpreted the average rate of hair growth (HSF.IF.B.6, HSN.Q.A.2, & HSF.LE.A.1.B), graphed linear functions to represent hair growth (HSF.IF.C.7.A), wrote functions to describe a relationship between the length of hair and the number of days passed (HSF.BF.A.1 & HSA.CED.A.2), and

made a prediction to determine the number of days needed for the hair to be long enough to be donated (HSF.LE.B.5, HSS.ID.B.6.C, & HSS.ID.C.7).

Several Standards for Mathematical Practices were addressed. They addressed Mathematical Practice 1, Make Sense of Problems and Persevere in Solving Them, because students worked on this challenge for an extended period of time. They addressed Mathematical Practice 3, Construct Viable Arguments and Critique the Reasoning of Others, because they had to prepare a team presentation to share their findings with their classmates and answer their questions. They also had to create a linear model to represent the situation and mathematically articulate several possible scenarios, such as the starting hair length, the desired hair length, and the impact of a potential hair cut to the donation timeline. In doing so they addressed Mathematical Practice 4, Model with Mathematics. Because the unit addressed all of these standards, and also targeted several 21st Century skills such as oral communication, collaboration, critical thinking, and work ethic, among others, it provided students with many opportunities to become college and career ready. Furthermore, the unit allowed for the students to be engaged as Mrs. Evans relates below.

I was so excited to see students jump into this project with eagerness. I saw a spark in them I had never seen before. They were tired of learning (or not learning) math through lectures and procedures! Students who always seemed to struggle were suddenly excelling. They were helping “the smart kids” write their equations and with their calculations. I didn’t have to circulate the room for the purpose of tapping the sleepers and the doodlers on the shoulders. Instead, I was able to circulate the room to hear the thoughts of my students and to question their thinking. Isn’t that how teaching math should always be?!?!

Project Highlights

Day 1 – Locks of Love: Entry Event and Introduction of the Project

There is a woman in our community who suffers from Alopecia Areata, a medical condition which causes hair loss on part or all of the body. We decided she would be the perfect guest speaker to get students interested in the Locks of Love organization. Her visit and talk served as our entry event. She came in to speak with students about Alopecia and how it has affected her life. She told the students how she went from being voted girl with “best hair” her senior year in high school to having no hair at all. She talked about the emotional, physical, and social effects the condition has had on her life. She then led the discussion towards a solution to the discomfort and ill effects that she and others like her have experienced. Students immediately started talking about the Locks of Love organization who became our community partner for the unit. A few had donated their hair before and were able to get a conversation going about the requirements. This and other scaffolding activities are listed in Table 1.

-----Insert Table 1 about here-----

[[Insert **Relationship** Tip #1 here: I made sure to have a discussion with students about what to expect before the guest speaker came in. I gave them a brief overview of what Alopecia is and started a discussion about what types of questions we may have for her. Students were to brainstorm at home that night and come prepared with a possible question for her the next day. If you were to implement this project, I would encourage you to prepare your students ahead of time for your guest speaker, if you choose to use one as your entry event.]]

I then posed the question, “How long would it take me to be able to donate my hair?” Students were hooked. They started talking about how long my hair was and that it depended on how fast my hair grows and some even mentioned that it also depended on how long I wanted it

to be once it was cut. I ended Day 1 of this unit by handing out the final rubric for the project (Figure 1). Students were told to look it over that evening and to come to class the next day with questions and/or suggestions for edits.

-----Insert Figure 1 about here-----

Day 2 –Hair Growth Estimation

Day 2 started with clarifying questions about the rubric. Students were nervous about the idea of presenting their final products, so we had a short discussion about whom the audience would be and how we would be informing/persuading them. We also discussed their options for the use of technology in their presentations. Students were given a spectrum of choices, which ranged from simply scanning their paper/pencil work and projecting it for their audience to see to creating a more professional presentation using Desmos.com or other graphing resources along with PowerPoint or similar presentation tools. Most students chose to simply scan their paper/pencil work. As I revise this unit, I see the use of graphing tools as beneficial and will incorporate this in future implementations of the unit. As I use those tools more often in class, students will become more comfortable with using them and, therefore, more likely to use them.

I then had students recall what they remembered from the discussion the day before about my hair and how long it would take me to grow my hair so that it was long enough to donate. I had them estimate what an average rate of hair growth might be. Their estimations varied greatly—from “2 inches per month” to “5 or 6 inches per year” to “an inch per week.” So, to assist them with determining a more accurate estimation, I introduced the video of Ryan’s hair growth from www.mathalicious.com. In the video, Ryan takes his picture each day for several weeks to show the length of his hair. Again, students were hooked. They loved this video and were immediately focused on estimating how much his hair had grown during each segment.

Students suggested a few different ways of recording the data and students decided a graph would be the most useful. So after graphing the data, we were then able to have a lengthy discussion about what the rate of change might be, what an average rate might be, and what the intercepts of the graph might mean. I included a mini lesson here to investigate other graphs, including those with different y-intercepts, zero slopes, and other slopes of all kinds. I used the resources in the Locks of Love unit from www.mathalicious.com for this mini lesson. Students were easily able to interpret the graphs in the context of hair growth and tell me what was happening with the hair of the people in those graphs.

[[Insert **Rigor** Tip #2 about here: Students can easily fall through the cracks during these mini lessons. Find time during the unit to assess each student individually on these skills. I have used homework as my assessment, which was somewhat effective. But, I prefer now to use an exit ticket/mini quiz as my assessment for these mini lessons. This gives me immediate feedback so that I am able to address any issues the next day when the students return. Use an assessment method that works for you and your students.]]

I then set them off to work in their groups on the driving question for the unit: How do we, as philanthropists, determine the amount of time necessary to grow our hair long enough for the purpose of donating it to “Locks of Love”? (see Project Planning Form in Table 2). Then, they were to choose one student’s results to discuss in their final presentation. Students couldn’t get the measuring tapes in their hands fast enough! The class ended too quickly for most of the students; they were so involved with their work that they didn’t want to leave class!

-----Insert Table 2 about here-----

Day 3 – Linear Equations: Putting it all Together and Presentation Preparation

Day 3 was exciting for me as a teacher. Students worked in groups more to finish up their individual predictions, but they soon noticed a pattern. They were doing all the same calculations for each person, just with different starting points. I used this as our next mini lesson (Figure 2). We were able to write a linear equation in slope-intercept form for each student in the class and they each understood exactly what the variables, the slope, and the y-intercept represented. It was a very quick mini lesson, but very beneficial. We discussed other contexts that could be modeled by linear equations in slope-intercept form and most students were easily able to write equations for these as well. That's when I really saw the benefits of this project. Writing linear equations is something my students have always struggled with, in class and on standardized tests. I worked with some students longer than others, but I was confident at the end of the unit that all students had mastered writing linear equations in slope-intercept form to represent a relationship between two quantities. Students' homework was to tie up any loose ends with their final products and to be ready to practice their presentations the next day.

-----Insert Figure 2 about here-----

[[Insert **Relationship** Tip #3 here: I often struggle with the issue of time. My class periods are only 50 minutes, so trying to fit work time and a mini lesson all into one class period is difficult. I plan to try a new strategy next year during this unit to try to minimize the time constraints. Miller (2011) offers 20 tips for managing project-based learning. He suggests forming students into teams and assigning them roles, one of which is team leader. Then, the teacher teaches a mini lesson or gives directions only to the team leader, who then reports out to and teaches his/her group.]]

Day 4 – Practice Presentations

Day 4 was rough, to say the least. Students understood the concept of how long it would take them to grow their hair for the purposes of donating it to Locks of Love and they had created great presentation materials, but they lacked experience and confidence with verbally communicating that information to an audience. So, we spent the day discussing important features of good presentation and speaking skills. By the end of the day, each group had presented while students in the audience scored them on the rubric and provided the presenters with "I like" and "I wonder" comments, a protocol commonly used in PBL to give feedback. This protocol is a great way for students to provide feedback using statements that could suggest next steps in a positive way. This gave each group the advantage of seeing others present, as well as giving them a chance to see what it was like to offer feedback to and assess someone else. Each group was also able to review the feedback they were given and make changes before the final presentation. I was so happy we had decided to include a day to practice their presentation.

-----Insert Figure 3 about here-----

Day 5 – Presentations

Because of the practicing, the presentations on day 5 were great. Students were organized, well spoken, and well prepared. But most of all, students had clearly learned the mathematical objectives of the unit. The audience consisted of me, an 11th grade English/Language Arts class down the hall and their teacher, the Principal and Assistant Principal of our Junior/Senior High School, and the Superintendent of our school district. I included the English/LA class since they had been working on persuasive speeches. I felt they would be able to provide my students with beneficial feedback on their presentation skills, as well as on the quality of their mathematical arguments. I had invited our guest speaker to the

presentations, but she was unable to attend. Looking back, it would also be useful to invite a representative from the Locks of Love organization.

Students from each group clearly explained the background of the problem and how they went about solving it. We had discussed, on Day 4, the importance of explaining this background information since most students did not include it in their practice presentations. Groups then explained the mathematical process for calculating the amount of time it would take for one of their group members to grow their hair long enough to donate it to Locks of Love (see sample student product, Figure 3). Since our audience consisted of mainly 11th grade students, I encouraged those students to use their mathematical knowledge and to question my students about the information they were presenting. This was a great way for me to see how well my students understood the learning objectives. Most groups ended their presentations with a persuasive piece. They needed to explain the importance of donating to the Locks of Love organization and I was blown away by their passion in doing so. Every group had a story to tell about an aunt, a parent, a friend who had undergone chemotherapy or suffered from other medical conditions that caused them to lose their hair. Their stories were quite persuasive, personable, and gave the audience a reason to donate hair, time, or even money to the Locks of Love organization. Diane Rodriguez, one of the designers of this project, and a student donated their hair to the Locks of Love organization at the end of the unit.

-----Insert Figure 4 about here-----

Addressing the Six A's

When developing this project the teachers had in mind the Six A's Criteria for Designing Projects (The Buck Institute of Education, 2003). By inviting the guest speaker and providing the context of the Locks of Love organization, the unit included Adult Connections and Authenticity.

Meeting someone who could benefit from this organization helped make the problem meaningful and relevant to the students. They saw it as a question that adults in the “real world” can tackle. During the day of the presentation the audience included other teachers and administrators, which provided for additional Adult Connections. The unit allowed students to demonstrate Applied Learning: they worked in teams, used technology, communicated ideas, and applied mathematical knowledge to a realistic and complex problem. Academic Rigor was addressed using a Driving Question that posed a challenge that would allow students to meet important Common Core Mathematics Standards.

The Common Core Standards (National Governors Association Center for Best Practices, Council of Chief State School Officers, 2012) call for three main shifts in mathematics: Focus, Coherence, and Rigor. Rigor is defined as pursuing conceptual understanding, procedural skill and fluency, and application with equal intensity. The teachers were motivated to design this unit because they had experienced some shortcomings when teaching the topic of linear function in the past. They realized that their students did not have a true understanding of the topic and the procedures they were using. The unit targeted conceptual understanding and application by having students model a real situation and using different mathematical representations to do so. The students learned different strategies from their classmates as they all presented their solutions to the group. This unit design helped address mathematical rigor. While the unit was rigorous and relevant, it also supported the students to develop personal relationships as Mrs. Evans describes below.

The relationships you have with your students, and the relationships your students have with one another, can really set the tone of the class for the entire year. I have found that because of this unit, my students feel more comfortable opening up to one another. They do not hesitate to

ask questions in class and they do not hesitate to help one another when they need it. Students also formed relationships with the guest speaker and their audience members, simply because they shared a personal story with one another. The five days spent on this unit saved countless hours of re-explaining concepts because a student was too afraid to ask for help during the initial explanation.

21st Century Workplace Skills

Seeley, former President of the National Council of Teachers of Mathematics, recently said, "...All students, whether they are headed toward STEM majors, business majors, other majors, or career paths not calling for four-year degrees, need to be prepared with workplace skills" (2013, p. 16). The Buck Institute for Education also acknowledges the importance of 21st century workplace skills. It notes:

Effective workers can productively utilize resources, interpersonal skills, information, systems and technology. Additionally, they demonstrate competency in basic skills in reading, writing, mathematics, speaking and listening; in thinking skills such as creativity, making decisions and solving problems; and in personal qualities such as individual responsibility, self-esteem, self-management, sociability and integrity. (2003, p. 26; see also http://www.bie.org/research/21st_century_skills).

The 21st century workplace skills that Mrs. Evans' intentionally imbedded into this unit include engaging students in:

- collaboration and decision-making;
- learning and applying social skills to navigate group interactions;
- using technology for learning and communicating;
- investigating dilemmas using problem-solving and critical thinking skills;
- using communication skills to present information generated through investigation, research and reasoning;

- developing an understanding of and empathy for another (ethics); and
- working together to take action regarding a social dilemma (civic responsibility).

Conclusion

In our professional development we were learning criteria for selecting good tasks. This unit provided us an opportunity to move from selecting good mathematical tasks to designing a project based unit. I am happy to say I am no longer disappointed at the end of my linear functions unit. I have taught this unit for two years now and am thrilled each year with the fact that students are able to write linear functions, interpret rate of change and intercepts, and identify other linear models in context. They retain all of this material and are easily able to apply it to later concepts in Algebra I, such as systems. This unit also taught students how to present material in a clear, organized way. Finally, I am thrilled with the life lesson they come away with after this unit. They have a new understanding and empathy for people with medical conditions such as Alopecia. A lot of students were able to reflect on their own experiences with family members and friends who had undergone chemotherapy during cancer. One student spoke for the first time about his mother, who had died of breast cancer. This unit was a great emotional outlet for him. Those types of lessons are greater than any math lesson I could ever teach them.

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I'M HAIR TO HELP

Failing Frizzies

So-So Strands

Hair Raising Heroes

(Below Performance Standards)

(Minimal Criteria)

(Demonstrates Exceptional Performance)

Criteria			
<p>Math Reasoning (30%)</p>	<ul style="list-style-type: none"> • Is able to recognize linear equations. • Fails to create a linear equation from the given data. • Can solve the equation, but cannot communicate how this relates to an individual person's donating timeline. <p>0 ----- 9 ----- 18</p>	<ul style="list-style-type: none"> • Creates a linear equation from the given data. • Can solve the equation, and somewhat communicate how this relates to an individual person's donating timeline. • Can articulate, mathematically, the importance of starting hair length. <p>19 ----- 22 ----- 26</p>	<p><i>In addition to meeting the ACCEPTABLE (So-So Strands) criteria ...</i></p> <ul style="list-style-type: none"> • Problem demands breadth and depth of specific knowledge of central concepts. • Can articulate, mathematically, the importance of desired ending hair length. • Discusses the meaning of a potential hair cut to donation timeline. <p>27 ----- 30</p>
<p>& Collaboration (20%) Work Ethic</p>	<ul style="list-style-type: none"> • Completes assignments only with encouragement • Completes assignments when class time is available, but does not do work outside of class • Is unengaged and unproductive during class discussions • Submits assignments after deadlines <p>0 ----- 6 ----- 12</p>	<ul style="list-style-type: none"> • Comes to class prepared • Contributes meaningfully to small group discussions • Completes in class assignment with steady focus • Does not create distractions for other students • Participates in group presentation • Completes out of class assignments with accuracy and detail • Completes peer and self-evaluations <p>13 ----- 15 ----- 17</p>	<p><i>In addition to meeting the ACCEPTABLE (So-So Strands) criteria ...</i></p> <ul style="list-style-type: none"> • Exhibits leadership regardless of project role • Seeks constructive feedback prior to project deadlines • Makes adjustments to improve project performance as recommended by instructor. <p>18 ----- 19 ----- 20</p>

I'M HAIR TO HELP

<p>“Final” Presentation (50%)</p>	<ul style="list-style-type: none"> • Body Language <ul style="list-style-type: none"> • Facial expressions distract from presentation. • Not enthusiastic. • Eye contact not maintained. • Speech <ul style="list-style-type: none"> • Volume too loud/soft for setting. • Words are not enunciated. • Pace of speech is difficult to understand. • Uses filler words (uh, um, like). • Presentation is less than 5 minutes. • Not all members participate. • Presentation is mostly data and non-persuasive. • Members do not answer the audience’s questions. • Members depend mostly on notes. 	<ul style="list-style-type: none"> • Body Language <ul style="list-style-type: none"> • Uses some enthusiasm (smile, inflection). • Eye contact maintained. • Speech <ul style="list-style-type: none"> • Volume is appropriate for setting. • Words are enunciated and speech is understandable. • Minimal filler words (uh, um, like). • Presentation is at least 5 minutes. • All members participate in some capacity. • Presentation is persuasive and uses data but not cohesively. • Members mostly answer the audience’s questions. • Members use some notes. 	<p><i>In addition to meeting the ACCEPTABLE (So-So Strands) criteria ...</i></p> <ul style="list-style-type: none"> • Body Language <ul style="list-style-type: none"> • Gestures, stance and expressions enhance presentation. • Talks directly to audience members who ask questions, as well as pulls others in. • Speech <ul style="list-style-type: none"> • Has enthusiasm and clarity. • Avoids filler words (uh, um, like). • All members participate equally. • Members do not read from notes. • Presentation uses data to persuade. Information is fluid; transitions from data to persuasiveness are smooth and well- rehearsed. • Members answer the audience’s questions completely and correctly (mathematically).
	<p>0 -----15 ----- 30</p>	<p>31 ----- 37----- -44</p>	<p>45----- 47----- 50</p>

Figure 1. Rubric for the “I’m Hair to Help” project

I'M HAIR TO HELP

Algebra 1 - I'm Hair to Help Unit

Name: _____

Writing Equations Practice

Date: _____ Class

Period: ____

- 1.) Jessie measured her hair on August 1st and again on September 1st. Her hair had grown $\frac{3}{4}$ inch in that month. Assuming her hair grows at a constant rate and knowing that her hair is 13 inches long right now, what is an equation that could represent her hair length over time? If she were to not cut her hair for 6 months, how long would her hair be?

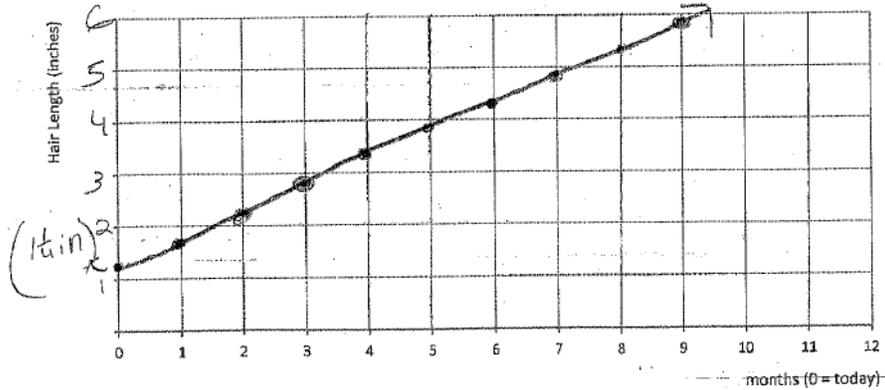
- 2.) David just shaved his head. He has an average hair growth of 6 inches per year. Write an equation that could represent his hair length over time (in months). How long would it take David to grow his hair to 4 inches, assuming he does not cut it?

- 3.) You and your family decide to rent a boat to have some fun on the lake while on vacation. There is a required deposit of \$125 for the 8 passenger pontoon boat, plus it costs \$109 per day. Write an equation to represent the cost of the boat over time. How much would it cost for you to rent the boat for 4 days? If all 8 family members were splitting the cost of the rental, how much would one person have to pay to rent the boat for 4 days?

- 4.) Your electricity went out last night and you are afraid of the dark. You had a candle that was 5 inches tall and was burning at a rate of $\frac{1}{4}$ inch per hour. Write an equation to represent the height of the candle over time. How long did you have candle light during your blackout? Did it last you all night or did you have to light another candle?

Figure 2. Writing Equations Mini Lesson for the "I'm Hair to Help" project

I'M HAIR TO HELP



$$y = 0.5x + 1.25$$

Alex has an average hair growth rate (1/2 inch per month).

Alex's hair is 1.25 inches long right now.

So, how long would it be before Alex could donate his hair to Locks of Love???

12.25 inches is how long Alex's hair would have to be before he would cut it because he wants to have 1.25 inches left after it's cut and we are allowing 11 inches to be cut (just to be safe).

$$12.25 = 0.5x + 1.25$$

$$\frac{11}{0.5} = \frac{0.5x}{0.5}$$

$$22 = x$$

So, it would take Alex about 22 months to grow his hair long enough to donate to Locks of Love.

Figure 3. Sample student product

I'M HAIR TO HELP

Table 1

Scaffolding Activities for the Unit “I’m Hair to Help”

SCAFFOLDING NTKs: Activity and Assessment Planning			
Knowledge and Skills Needed by Students	Scaffolding / Materials / Lessons		
	Provided by the project teacher, other teachers, experts, mentors, and community members in order to successfully complete culminating products and performances, and do well on summative assessments		
Anticipated Need to Know	Assignment/activity/action to address NTK	Assessment used for assignment/activity/action	Learning Outcomes Addressed in assignment
What is Locks of Love and why would someone need it?	Guest speaker and discussion	Persuasive/informative presentation at end of unit	Students should have an understanding of what the guest speaker has had to deal with (medically, emotionally, socially, & cosmetically).
What is an average hair growth rate?	Discussion and video of Ryan’s hair growth over a year	Participation and application of average hair growth rate in final products	Students should be able to find the average for hair growth to predict how long it will take for their hair to grow the required 10 inches for locks of love.
What do the slope and intercepts of the graph represent?	Mini lesson	Students asked to interpret 3 other graphs representing hair length over time	Students should be able to interpret the meaning of the slope and intercepts of a graph with regards to a context.
How do I write a linear equation to represent the context?	Mini lesson and discussion	Presentation at end of unit and quiz at end of unit	Students should be able to write a linear equation to represent a context.
How do I present my findings in an organized and effective way?	Practice presentations with feedback	Final presentations at end of unit	Students should be able to design a multi-media persuasive presentation involving all group members.

Table 2

Project planning form for the “I’m Hair to Help” project

Project Planning Form

Name of Project: I'm Hair to Help	
Designed by Teacher(s) and Email(s): Julie Evans, Diane Rodriguez, Melodie Miller, Rita Cox jevans@bsd.k12.in.us , droduiguez@bsd.k12.in.us , mmiller@egreene.k12.in.us , rcox@lssc.k12.in.us	
Project Idea (What is the issue, problem or theme of this unit?)	Students will be challenged to determine how long it would take them to grow their hair long enough to donate it to Locks of Love, a non-profit organization that provides hairpieces to financially disadvantaged children suffering from long-term medical hair loss. They will have to research the regulations on donating their hair to the organization, as well as average hair growth rates in order to determine how long it would take. Finally, students will present their findings and give a persuasive/informative speech to try to encourage others to donate their hair to the organization and to explain why it is important to consider donating.
Topic(s) addressed: List one or more topics this project addresses.	Write linear equations, interpret the slope and intercepts of a linear model, draw a “best fit” line for a scatter plot and determine the slope of that line
Essential Question (Driving Question or challenge)	How do we, as philanthropists, determine the amount of time necessary to grow our hair long enough for the purpose of donating it to Locks of Love?
Entry Event (What is the hook to launch this project?)	Guest Speaker: Someone who has benefitted from Locks of Love / lost hair due to medical issue.
CCSSM and Standards for Mathematical Practices (to be addressed in the project)	<p>HSN.Q.A.2 – Define appropriate quantities for the purpose of descriptive modeling.</p> <p>HSA.CED.A.2 – Create equations in two or more variables to represent relationships between quantities; graph equations on coordinate axes with labels and scales.</p> <p>HSF.IF.B.6 – Calculate and interpret the average rate of change of a function (presented symbolically or as a table) over a specified interval. Estimate the rate of change from a graph.</p> <p>HSF.IF.C.7.A – Graph linear functions and show intercepts.</p> <p>HSF.BF.A.1 - Write a function that describes a relationship between two quantities.</p> <p>HSF.LE.A.1.B – Recognize situations in which one quantity changes at a constant rate per unit interval relative to another.</p> <p>HSF.LE.B.5 – Interpret the parameters in a linear or exponential function in terms of a context.</p>

I'M HAIR TO HELP

		<p>HSS.ID.B.6.C – Fit a linear function for a scatter plot that suggests a linear association. HSS.ID.C.7 – Interpret the slope (rate of change) and the intercept (constant term) of a linear model in the context of the data. MP1 Make sense of problems and persevere in solving them. MP3 Construct viable arguments and critique the reasoning of others. MP4 Model with mathematics.</p>											
		T = Teach; P = Practice; A=Assessed			T	P	A	T = Teach; P = Practice; A=Assessed			T	P	A
Learner Outcomes (21 st Century Skills addressed: taught, practice, and/or assessed)	Written Communication			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Technology Literacy			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Oral Communication			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Work Ethic			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Collaboration			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Civic Responsibility			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Critical Thinking			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Numeracy			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
	Information Literacy			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	Core Content Skills			<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	
Habits of Mind: (Indicate 1 or 2 habits of focus in this unit.)	<input type="checkbox"/> Persisting			<input type="checkbox"/> Thinking about thinking			<input type="checkbox"/> Communicating with clarity			<input type="checkbox"/> Taking responsible risks			
	<input type="checkbox"/> Managing impulsivity			<input type="checkbox"/> Striving for accuracy/precision			<input type="checkbox"/> Gathering data – all senses			<input type="checkbox"/> Finding humor			
	<input type="checkbox"/> Listening to others			<input type="checkbox"/> Questioning/posing problems			<input type="checkbox"/> Creating, imagining, innovating			<input type="checkbox"/> Thinking interdependently			
	<input type="checkbox"/> Thinking flexibly			<input type="checkbox"/> Applying past knowledge			<input type="checkbox"/> Responding with awe			<input type="checkbox"/> Learning continuously			
Presentation Audience													
Student Production	Group Products: (major types)			Presentation to another group of peers, including a visual representation of their calculations (informative and persuasive)						Check all that apply: <input type="checkbox"/> Class <input type="checkbox"/> School <input type="checkbox"/> Community <input type="checkbox"/> Experts <input type="checkbox"/> Web (public) <input type="checkbox"/> Parents <input type="checkbox"/> Other: Locks of Love representative, Guest speaker			
	Individual Products: (major types)			Peer and Self Evaluations, Individual calculations/graphs									
Rubric(s) used for this project (check and describe all		<input type="checkbox"/> Multimedia presentation rubric			<input type="checkbox"/> Other: Math reasoning rubric								
		<input type="checkbox"/> Oral presentation rubric			<input type="checkbox"/> Other: Work ethic & collaboration rubric								
		<input type="checkbox"/> CCSS ELA & literacy writing rubrics			<input type="checkbox"/> Other: Daily peer and self-evaluations								

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Assessments & Reflection	that apply)	<input type="checkbox"/> School writing rubric	<input type="checkbox"/> Other:	
		<input type="checkbox"/> School learner outcomes rubric	<input type="checkbox"/> Other:	
	Assessment type(s) used for this project (check and describe all that apply)	<input type="checkbox"/> Quiz:	<input type="checkbox"/> Performance Assessment: Practice presentations and daily peer evaluations	
		<input type="checkbox"/> Test: At end of unit	<input type="checkbox"/> Notes review:	
		<input type="checkbox"/> Essay:	<input type="checkbox"/> Checklist:	
	Reflection tools (check and describe all that apply)	<input type="checkbox"/> Online Assessment:	<input type="checkbox"/> Concept Maps:	
		<input type="checkbox"/> Survey:	<input type="checkbox"/> Focus Group	
<input type="checkbox"/> Discussion: Throughout project		<input type="checkbox"/> Personal Learning Plan		
	<input type="checkbox"/> Journal	<input type="checkbox"/> Student/Teacher Conference: Discuss individual calculations/graphs		
Project Resources	On-site personnel:	Audience		
	Technology:	Internet access, Projector, Graphing software		
	Community resources:	Guest speaker, Audience		
	Print resources:	Blank graphs, Poster board		
	Online resources:	www.mathalicious.com , www.locksoflove.org		

Steps of PBL Process	NTK's	Scaffolding	Status check to move to next Phase
Phase One What is the need/problem?	How fast does hair grow? How are we forming groups? What product is expected?	<ul style="list-style-type: none"> • Guest speaker • Driving question • Research hair growth online • Homework: Review assessment rubric and bring questions to next class 	<ol style="list-style-type: none"> 1. Students can explain the problem during class discussion. 2. All questions from students have been answered during class discussion at the end of lesson 1. 3. Work ethic and collaboration rubric.
Phase Two What needs to be in our solution?	What is an average hair growth rate? What do the slope and intercepts of the graph	<ul style="list-style-type: none"> • Discussion and video of Ryan's hair growth over a year • Homework from Lesson 1: 	<ol style="list-style-type: none"> 1. Students can find the average for hair growth. 2. Students can articulate what a quality product looks like according to the rubric. 3. Work ethic and collaboration rubric.

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	represent?	Answer questions about rubric. Continue research on hair growth	
Phase Three What are possible solutions?	Can I use a graph? Do I need to use an equation? What representations do we need to include in our presentation?	<ul style="list-style-type: none"> • Mini Lesson “Writing Equations.” 	<ol style="list-style-type: none"> 1. Students can articulate their solution and explain how they arrived at the solution. 2. Work ethic and collaboration rubric
Phase Four What solution should we use?	How do I generalize the solution?	<ul style="list-style-type: none"> • Rubric criteria for Math Reasoning 	<ol style="list-style-type: none"> 1. Teacher’s notes in observation checklists. 2. Work ethic and collaboration rubric.
Phase Five How do we create, run and inspect our solution?	Is the information I am giving to my audience clear? Can I prove that my solution is correct?	<ul style="list-style-type: none"> • Use “I likes and I wonders” during practice presentations 	<ol style="list-style-type: none"> 1. Grade practice run using the rubric. 2. Work ethic and collaboration rubric.
Phase Six Reflect back: Did we solve the problem? Do we have a new problem?	What questions might the audience ask us? How do we field audience questions?	<ul style="list-style-type: none"> • Questions asked by the audience • Project rubric 	<ol style="list-style-type: none"> 1. Grade the presentation using the rubric. 2. Work ethic and collaboration rubric.

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Table 3

Lesson plan for Day 1: Entry Event and Introduce the Project

Concept(s) Possible medical background of guest speaker; Empathy; Basic discussion of how quickly hair grows; How to use a rubric
Learning Targets Students should leave today with a better understanding of what the guest speaker has had to deal with (medically, emotionally, socially, & cosmetically). Students will work in pairs or small groups to devise a plan for calculating the average amount that hair grows (within a time period to be determined by each group of students).
Standard/Indicators MP1
Materials & Resources: Guest Speaker, Rubric
Three-Part Lesson Format Note: <ul style="list-style-type: none">• Discuss the guest speaker's background• Think about appropriate questions for guest speaker Before / Launch (Getting Ready) <ul style="list-style-type: none">• Guest Speaker (Hook - get students interested, show the importance of the project) During / Investigate (Students Work) <ul style="list-style-type: none">• Present the driving question: "How do we, as philanthropists, determine the amount of time necessary to grow our hair long enough for the purpose of donating it to Locks of Love?"• Basic discussion of how to go about solving this type of situation (within groups)• Listen carefully to their thoughts and ideas (and ask questions)• Include questions to prompt students' thinking, such as "What types of things do we need to know about our hair in order to know how long it will take to grow 10 inches?" and "What other important things do we need to know about our hair before we start to grow it out/before we cut it?"• Observe and assess (On Days 1 - 3, I simply record a list of thoughts next to each student's name on a class list —What ideas/questions did each student have? What input did each student give?) After / Summarize (Class Discourse) <ul style="list-style-type: none">• Class discussion to bring ideas together• Encourage a community of learners (encourage student-student dialogue, require justifications, call on students for their ideas, encourage students to ask questions, be certain your students understand what you understand, move students to more conceptually based explanations)• Accept students' solutions without evaluation• Summarize main ideas and identify hypotheses
Homework <ul style="list-style-type: none">• Look over rubric and be ready to ask questions/make suggestions tomorrow

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Table 4

Lesson plan for Day 2: Estimate Hair Growth

Concept(s) <i>Estimation, Graphing, Slope, Y-Intercept, Predictions, Writing Equations, Line of Best Fit, Measurement.</i>
Learning Targets <i>Students should be able to interpret the meaning of the slope and y-intercept. Students should be able to (after watching video) apply their plan (from Day 1) for finding the average for hair growth to predict how long it will take for their hair to grow the required 10 inches for locks of love.</i>
Standard/Indicators F.LE.1.b, F.LE.5, F.IF.6, A.CED.2, N.Q.2, F.IF.7.a, S.ID.6.c, S.ID.7, MP1, MP3, MP4
Materials & Resources: <i>Locks of Love Video (www.mathalicious.com), Blank Graphs, Graphing Software (Math Tools)</i>
Three-Part Lesson Format Before / Launch (Getting Ready) <ul style="list-style-type: none">• Recall discussion from yesterday• Rubric questions and suggestions During / Investigate (Students Work) <ul style="list-style-type: none">• Working in groups• Video (estimating hair growth)• Graph hair growth from video.• Individual predictions and graphs.• Let go! (Let them struggle and let them solve the problem. Remind yourself that this is only day 2, so they may not have a perfect understanding of what to do yet. It's ok, let them try to work through it together.)• Listen carefully to their thoughts and ideas.• Include questions to prompt students' thinking, such as "In our graph representing Ryan's hair growth, it seems his hair continuously gets longer. What would our graph look like if he had cut his hair after two months?"• Provide hints (with caution, avoid being the source of truth). Again, they will learn by struggling ... Let them.• Observe and assess (On Days 1 - 3, I simply record a list of thoughts next to each student's name on a class list ... What ideas/questions did each student have? What input did each student give to class and/or group discussions? Etc...) After / Summarize (Class Discourse) <ul style="list-style-type: none">• Class discussion to address questions.
Homework

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- Finish up any graphs/calculations
- Think about any issues that you ran into today (Do you need a mini lesson to help you through those issues?)
- Think about presentation ideas

Table 5

Lesson plan for Day 3: Putting it all together/Prepare Presentations

Concept(s) <i>Estimation, Graphing, Slope, Y-Intercept, Predictions, Writing Equations, Line of Best Fit, Measurement.</i>
Learning Targets <i>Students should be able to design a multi-media presentation (any necessary things here—such as graphing software, PowerPoint, MS Word.) involving all group members that convinces the audience how long it will take for their hair to grow the required 10 inches for locks of love.</i>
Standard/Indicators <i>CCSS.ELA-Literacy.SL.9-10.4, CCSS.ELA-Literacy.SL9-10.5</i>
Materials & Resources: <i>Blank Graphs, Graphing Software (Math Tools)</i>
Three-Part Lesson Format Before / Launch (Getting Ready) <ul style="list-style-type: none">• Pick up from where we left off yesterday• Are there any issues? Do we need to have any mini lessons? During / Investigate (Students Work) <ul style="list-style-type: none">• Working in groups• Finish up individual predictions and graphs.• Prepare final product (graphs and presentation)• Listen carefully to their final thoughts (and ask questions). This will help prepare them for their presentation.• Include questions to prompt students' thinking, such as "If I were an audience member who knew nothing about linear equations, would I understand your explanation of your graph?" and "Does your presentation clearly explain why it is so important to consider donating your hair to Locks of Love?"• Provide hints (with caution, avoid being the source of truth). Students should have a fairly solid understanding at this point. If they do not, more guidance may be necessary. Consider revisiting mini-lessons, if necessary.• Observe and assess (On Days 1 - 3, I simply record a list of thoughts next to each student's name on a class list ... What ideas/questions did each student have? What input did each student give? Etc...) After / Summarize (Class Discourse) <ul style="list-style-type: none">• Class discussion to address questions• Discussion of presentation expectations
Homework <ul style="list-style-type: none">• Finish up presentations

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- Be prepared for presentations tomorrow

Table 6

Lesson plan for Day 4: Practice Presentations

Concept(s) <i>Estimation, Graphing, Slope, Y-Intercept, Predictions, Writing Equations, Line of Best Fit, Public Speaking, Informative/Persuasive Speaking.</i>
Learning Targets <i>Students should be able to design a multi-media presentation (any necessary things here—such as graphing software, PowerPoint, MS Word.) involving all group members that convinces the audience how long it will take for their hair to grow the required 10 inches for locks of love. Each student should know his/her role in the presentation.</i>
Standard/Indicators CCSS.ELA-Literacy.SL.9-10.4, CCSS.ELA-Literacy.SL9-10.5
Materials & Resources: <i>PowerPoint, Poster Board, Graphing Software (Math Tools), any other materials students have indicated a need for</i>
Three-Part Lesson Format Before / Launch (Getting Ready) <ul style="list-style-type: none">• Final clean up questions/discussion• Reminder of what needs to be included in presentation (rubric)• Reminder that individual predictions and graphs must also be completed and turned in tomorrow During / Investigate (Students Work) <ul style="list-style-type: none">• Observe students' practice presentations• Score other groups using rubric and provide feedback using "I likes" and "I wonders"• Working in groups• Final work time for groups to discuss feedback After / Summarize (Class Discourse) <ul style="list-style-type: none">• Class discussion to address final questions• One last reminder of presentation expectations
Homework <ul style="list-style-type: none">• Finish up presentations using feedback given by teacher and other students• Be prepared to present tomorrow• Have individual products ready to turn in tomorrow

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Table 7

Lesson plan for Day 5: Presentations

Concept(s) <i>Estimation, Graphing, Slope, Y-Intercept, Predictions, Writing Equations, Line of Best Fit, Public Speaking, Informative/Persuasive Speaking.</i>
Learning Targets <i>Students should be able to engage the audience with a multi-media presentation (any necessary things here—such as graphing software, PowerPoint, MS Word.) involving all group members that convinces the audience how long it will take for their hair to grow the required 10 inches for locks of love. Each student in the group should perform a role in the presentation.</i>
Standard/Indicators F.LE.1.b, F.LE.5, F.IF.6, A.CED.2, N.Q.2, F.IF.7.a, S.ID.6.c, S.ID.7, MP1, MP3, MP4, CCSS.ELA-Literacy.SL.9-10.4, CCSS.ELA-Literacy.SL9-10.5
Materials & Resources: <i>PowerPoint, Poster Board, Graphing Software (Math Tools), any other materials students have indicated a need for</i>
Three-Part Lesson Format Before / Launch (Getting Ready) <ul style="list-style-type: none">• Final group discussions to get ready for presentations• Introduce audience During / Investigate (Students Work) <ul style="list-style-type: none">• Observe and assess (using rubric) students' presentations (The "Final Presentation" portion of the rubric is completed by both the teacher and the audience members. The rest of the rubric is completed by the teacher only.) After / Summarize (Class Discourse) <ul style="list-style-type: none">• Class discussion with audience - This was a debriefing time where the audience gave individual groups positive feedback. This was a very positive discussion. Students left class that day feeling good about the project and what they had learned and shared with others.
Homework <ul style="list-style-type: none">• None