



From the Future

A lesson to accompany your unit on *Biological Evolution* (NGSS 6.MS-LS4-1)

Story

This “From the Future” lesson reinforces the engineering design cycle (Define, Develop, Optimize) – with an emphasis on Optimize – through the story of Alejandra, a lonely 14-year-old from the year 2108 who is worried about starting ninth grade. During a class field trip, Alejandra discovers a smartphone from the past (our time). Much like a fossil, the phone contains data about who owned it and the world he lived in: a boy named Dax who, like Alejandra, is lonely and nervous about starting high school.

Searching deeper, Alejandra finds phones that are even older. To Alejandra, it looks like these phones have evolved over time to improve (optimize) people’s ability to communicate with each other. As students help Alejandra sort the phones on a timeline, they see how technological evolution is different from and the same as biological evolution.

How Technological and Biological Evolution are **DIFFERENT** and the **SAME**

Technological Evolution:

*Humans decide to change phone designs (they **define** the problem). The changes in phone designs improve (optimize) our ability to communicate. This happens over a short time.*

Biological Evolution:

*Random differences and natural selection change life forms. The changes in life forms improve (**optimize**) their ability to survive. This happens over a VERY long time.*



About 2 class periods



Relevant Engineering Standard:
NGSS MS-ETS1

Printed Documents

You will need printed copies of the following documents, which can be found online at *teemsproject.com*. Navigate to the unit “From the Future,” and scroll down to the *Quick Links to Resources* sections.

You will be breaking your class into groups of 2 to 3 students. The following numbers are PER GROUP except as noted.

*Optional resources: Print these out if you feel students will have trouble seeing them projected at the front of the class.

Section	Document Name	Number of Copies
Dax’s Phone	Dax’s Conversation Soccer Club Confusing Cartoon What’s This? Screen Time High School mApp	1 per group for each of these documents
The Timeline	*Optional: Horse Chart *Optional: Alejandra’s Timeline Phone Timeline Timeline Clues Dot Timeline	1 per group for each of these documents. Print an extra copy of the phone timeline for yourself. One for the entire class

Printed Documents Cont'd



Section	Document Name	Number of Copies
Design Challenge: A Better App	Design Report	1 per group for each of these documents
	App Sketch #1	
	App Sketch #2	
App Sample		
	Fifth Grader Stories: Jayden Olivia Skylar Gabriel Theodore Camila	Print at least one copy of each story. NOTE: Each group gets only ONE of these Fifth-Grader Stories. If you have more than six groups, then print more than one copy (so some groups will have the same story).
	Feedback Report	1 per student .

Teacher Prep

Sections / Document Names

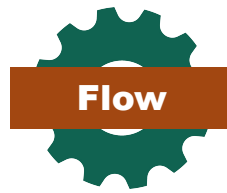
The Timeline
Phone Timeline

Prep

For each group, cut this resource into 8 separate pieces - one phone per piece - so that students can sort the phone designs. (If you'd rather, you can also ask students to cut out the phones when they do the activity).

Teacher Tips

- ⚙ When you access From the Future online, for the best experience, view your browser “full screen.”
- ⚙ For any resource document that you open, you can click on it to zoom in for a closer look. Then use your mouse or touchpad to drag the document up or down.
- ⚙ Close any resource by clicking on the X in the upper right corner.



Flow of the Lesson

Alejandra's Story

p. 6

Students meet Alejandra, a lonely ninth-grader from the year 2108, and follow her on a field trip where she discovers a mysterious old phone.

Dax's Phone

p. 9

Alejandra digs through the data on the phone, trying to decipher the apps and messages from 100 years ago.

The Timeline

p. 14

Alejandra discovers more phones from the distant past. It looks like the designs are improving over time. But Alejandra needs help putting them in order to see their evolution from the very first phone to the smartphone.

Design Challenge: A Better App

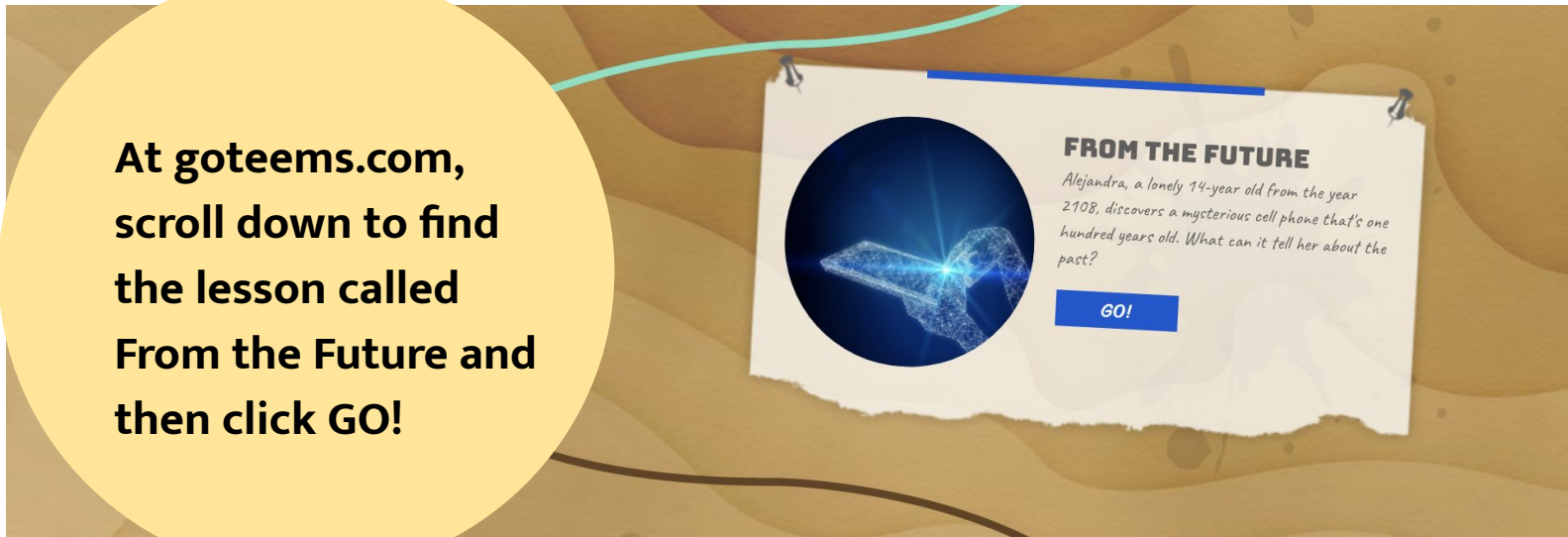
p. 27

Taking the next step in the evolution of phone designs, students design an app for fifth-graders making the transition to 6th grade.

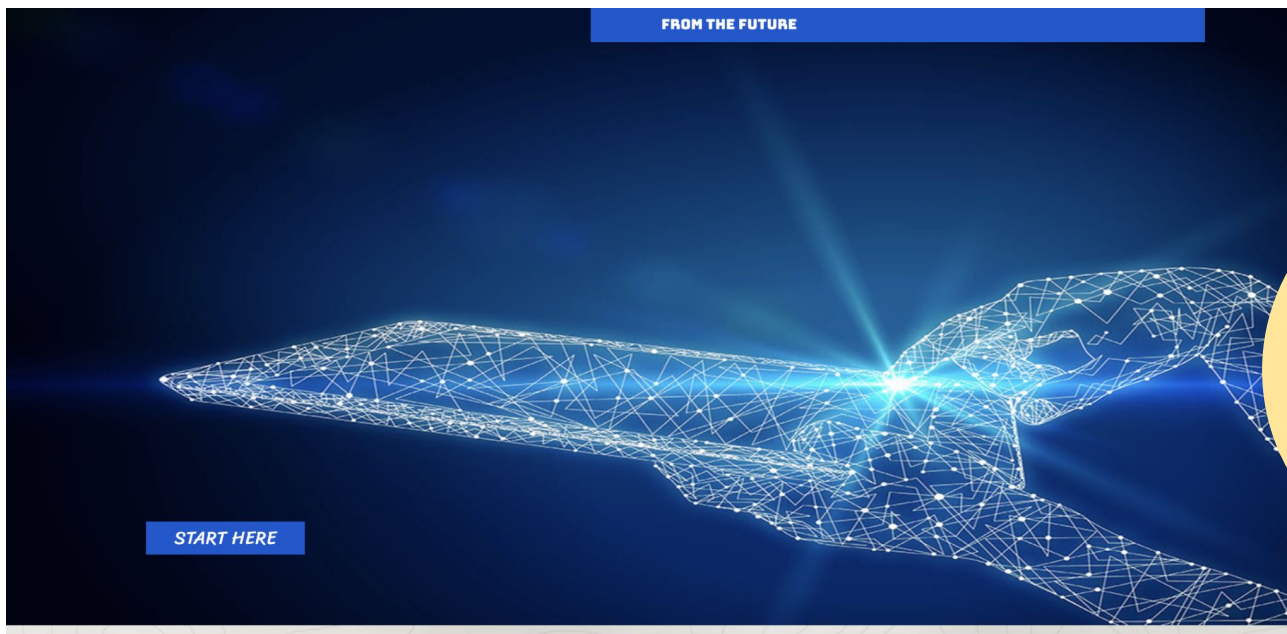
Alejandra's Story: Steps

1.

At goteems.com, scroll down to find the lesson called From the Future and then click GO!



2.



Then, project this screen for the class


3. Click the Start Here button to open a 2-minute video. The video will start automatically. Watch and listen to the story as a class.

4. When the video ends, close the viewer and engage students in a discussion using the questions below and at the top of the next page.


 **What year does Alejandra live in?**

 She lives in the future: in the year 2108.


 **Where was Alejandra's class going on a field trip, and why didn't she want to go?**

 The field trip was to the ruins of a school building from a long time ago. Alejandra didn't want to go because she felt lonely, with no friends to talk to.


 **What did Alejandra find in the rubble?**

 A smartphone from our time.

 **Why did Alejandra think the phone was like a fossil?**

 The fossil of an animal can tell things like where it lived, what it ate, and how old it was. The data on the smartphone could tell us things about the person who owned it.





 **What does Alejandra want to find out about the person who owned the phone?**

 She wants to know who this person was and the world they lived in. She wonders if the person had lots of friends – or was lonely like her.

Talk About This



Talk About This Cont'd

-  **What do you think the information on this smartphone might tell about the person who owned it? Think about the kinds of things your phone might tell about you (or, if a student doesn't have a phone, think about what a parent's or friend's phone might tell about them.)**
 -  Responses will vary. Encourage students to share a variety of answers. For example: The person's name, who the person's friends were, what the person liked to do.
-  **Do you think engineers plan for what will happen to their designs in the future? What might they consider as part of their plan?**
 -  Responses will vary. Encourage students to share a variety of answers and explain their reasons.

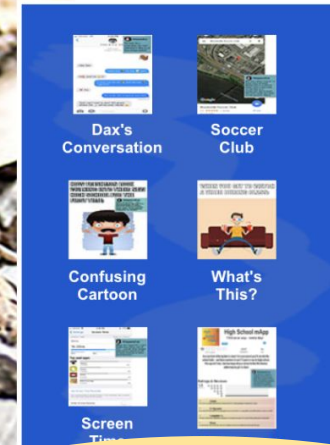
5. Remind students: *Alejandra was excited to find out more about the smartphone's owner. Let's see what happened next.*

Dax's Phone: Steps

1.

"THAT'S WHEN I SPOTTED IT: SOMETHING SHINY IN THE RUBBLE. I GRABBED IT BEFORE ANYONE ELSE SAW IT."

Alejandra in the Year 2108



At goteems.com/lessons/from-the-future, scroll down to Resource Block One. Project this screen for the class.

2.

Explain to students: *Like Alejandra said in the video, a fossil of a bone can tell us a lot about the animal it came from. She thinks the old smartphone she found could be like a fossil: it could give her information about the person who owned it. But this phone is from our time, and Alejandra lives in 2108 – so there are many things she doesn't understand. We're going to look at what Alejandra found and see what we can learn from it.*

3.

Click on the resource **Dax's Conversation** to open it. Read the note from Alejandra aloud to the class. Ask students the questions below and at the top of the next page:



What did Alejandra find?



Text messages between two people



Why is she confused by it?



The texts use emojis, which she doesn't understand.



Let's see if we can help Alejandra out. [Read the text messages aloud with the class, asking students to identify what the emojis mean. The words in brackets are emojis]



Person 1: **[Hi]**



Person 2: Hey Dax



Person 1: Have you **[studied]** for the **[test]** yet?



Person 2: **[No]** and I'm **[worried]**!!!



Person 1: Come over to my **[house]** and we can **[study]** together



[Perfect thanks]



No prob! We're gonna ace this!



Yeah can't wait to start 9th grade where the **[tests]** will be even harder
[sad emoji]

Talk About This

- ⚙️ **What do these texts tell us about the person who owns the phone?**
- ⚙️ Responses will vary. As needed, prompt students with:
 - ⚙️ Can we figure out the names of the two people having the conversations? [At the top of the screen, we can see that the person sending the messages is named Chase Ellis. He says “Hey Dax” – so the owner of the phone must be named Dax.]
 - ⚙️ Can we figure out what grade they’re in? [Dax’s friend Chase says “Can’t wait to start 9th grade” – so they must be in 8th grade now.]
 - ⚙️ What are they worried about? [That the tests in 9th grade will be harder.]

4. Explain to students: *We already know a lot about the phone’s owner – like his name, his friend’s name, and his grade. Now we’re going to see what else we can find out about Dax.*
5. Divide your class into groups of 2 to 4 students. Give every group a printed copy of all six resources: **Dax’s Conversation, Soccer Club, Confusing Cartoon, What’s This, Screen Time, and High School mApp.**

6.

Give each group time to explore the resources in the same way that you explored Dax’s conversation as a class. After students have explored the resources, ask each group to share one or two things they learned about Dax. The table below can help you guide students if needed:



Resource	What does Alejandra think about what she found?	What did Alejandra really find?	What does this tell us about Dax?
Dax’s Conversation	She knows it’s a conversation but she doesn’t understand the emojis.	Text messages	His name: Dax His friend’s name: Chase His age: 8th grade
Soccer Club	She thinks it’s a picture taken from a “sky-train” on its way to a restaurant that serves a food called “soccer”	A map with a pinned location	One of his interests is playing soccer
Confusing Cartoon	She thinks pictures like this tell people how their faces should look in different situations (like walking into high school)	A meme about starting high school	His emotions: he’s worried about starting 9th grade
What’s This?	---	A meme about watching videos in class	His sense of humor: silly memes
Screen Time	She figures out that the number (1hr 20m) is how much time Dax spends looking at these different apps.	A record of how much time Dax spent on different apps	How he communicates with friends Most of his phone time is spent on the mAPP
High School mApp	She thinks it’s strange that people in 2019 use phones for directions. In her time (2108), people have navigation implants in their eyes.	An app to help students make their way around high school	Dax uses this app so he must be worried about starting high school. The reviews show that the app doesn’t work very well (it needs improvement).

7. Discuss the questions below with students:

 Like we've said before, fossils of bones can tell us a lot about the animals they came from. If someone from 100 years in the future found your phone, do you think it would help them understand who you are?

For students who don't have a phone: If someone from the future found your backpack or saw your room, would it help them understand who you are?

 Responses will vary. Encourage students to explain their reasoning.

 What different kinds of information would a phone give about you compared to your room or backpack?

 Responses will vary.

 For any of these things (your phone, backpack, or room) what kinds of information about you might be missing?

 Responses will vary.

 If you were an engineer, what parts of phones would you want to design?

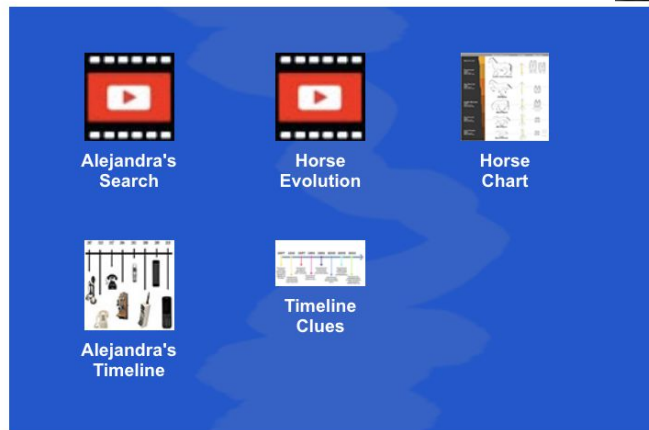
 Responses will vary.

Talk About This

8. Remind students: *Alejandra found this smartphone on her field trip to an old school building. Let's see what happens next.*

The Timeline: Steps







1.



At goteems.com/lessons/from-the-future, scroll down to Resource Block Two. Project this screen for the class.

2. Click the resource **Alejandra's Search** to open the 30 second video. The video will start automatically. Watch and listen to the story as a class.

- 3.** When the video ends, close the viewer. To check understanding, you can ask students the questions below.

-  **What else did Alejandra find in the rubble?**
 -  She found more old phones from the past.
-  **What did Alejandra notice about the phones' designs?**
 -  They looked like they might be getting better at helping people communicate with (talk to) each other.
-  **What did Alejandra do with the phones she found?**
 -  Put them in order, from oldest to newest, to see how they changed - and improved - over time.

Talk About This

Take note!

The resources Horse Evolution and Horse Chart provide a tie-in to concepts in SPS Grade 6 Science Unit #3: Biological Evolution and can be used as an enhancement to NGSS 6.MS-LS4-1 (Biological Evolution: Unity and Diversity)


4. Explain to students: *Alejandra, like us, learned about fossils and evolution in school. She knows that by looking at fossils of an animal over a really long time, you can see how it changed and evolved. So, to help her figure out how the phone designs changed over time, first she decides to look at the evolution of the horse.*
5. Click on the resource **Horse Evolution** to open the 2-minute video. The video will start automatically. Watch and listen to the video as a class. When the video ends, close the viewer.
6. Click on the resource **Horse Chart** to open the image. Engage students in a discussion about the video and the chart of horse evolution (in the context of what your students have learned about evolution and natural selection in your classroom) using the questions below and on the next page.

 **In the video and on this chart, what are some of the changes you see over time?**


 The horse got bigger

 Its legs got longer

 Its teeth got bigger and formed ridges

 Its foot started with several toes and ended with one toe (hoof)

 **Over how much time did these changes happen?**

 The evolution of the horse happened over a **very long time** ... about 50 million years.

Very early horses lived in wet forests. Having a foot with several toes made it easier for them to walk on wet ground. But today, horses live in fields, and it's easier for them to walk on a foot with one toe (called a hoof). What about the other changes we see – how did these changes help the horse be better at surviving?

- Longer legs helped make the horse faster so it could run away from predators.
- Bigger teeth with ridges made it easier for horses to grind up and eat tough blades of grass.

How did the changes happen?

- Some early horses happened, by chance, to have taller teeth with a few ridges. (TEACHERS: if you have covered genetic mutation in class, that term could be used here.) They could eat the tough grass that horses with smaller teeth couldn't, so they were more likely to survive.
- When they had offspring (babies), these offspring also tended to have taller, ridged teeth. (Just like if both of your parents have brown eyes, you'll probably have brown eyes.) And these offspring could also eat the tough grass and survive.
- This went on for millions of years. The horses' teeth very, very slowly got bigger and had more ridges – because that helped them eat more grass and survive.
- This process is called **natural selection**.

Talk About This Cont'd

7. Click on the resource **Alejandra's Timeline** to open the image. You can also hand out printed copies. Ask students:

⚙️ **Alejandra put all these phones in what she thought was the right order, starting with the very oldest. What do you think: do you agree with the order she put the phones in?**

⚙️ Answers will vary. Students will have more time to explore this, so you don't need to make sure they get the "right answer." Instead, encourage a variety of responses and encourage students to share their reasons.

Talk About This

8. Explain to students: *Just like Alejandra, you might never have seen some of these phones before. But we'll try to put the phones into order ourselves, from oldest to newest.*








Remember, looking at the images of the horse, we can see how it changed over time, and we can see why those changes made it easier for the horse to survive.





So, as we put the phones in order, think about why the phone designs might have changed over time. How does each phone design evolve—that is, how does it get better at helping people talk to each other?

9. Divide your class into groups of 2 to 3 students. Give each group one pack of cut-out phone images that you've prepped for them. **Keep one pack of cut-outs for yourself, which you'll use in Step 15.**
10. Give students time to arrange the phones. Emphasize that they are looking for how the phone designs changed and got better over time at helping people talk to each other.
11. When the groups have finished their first attempt at ordering, give each group a printed copy of the resource **Timeline Clues**. Explain to students: *Alejandra's teacher gave her some clues about how the phone designs got better over time. Use the clues to see if you can improve how you put the phones in order.*
12. When groups have improved their attempts at ordering, come together as a class to discuss their timelines and walk through the improvements in phone design.

The correct timeline is available to teachers in the resource **Correct Timeline** [available at teemsproject.com on the "From the Future" lesson page.] In addition, the table on the next two pages can help you guide discussion as outlined below.









Begin by displaying your cut-out of Phone #1 (for example, by taping it to your whiteboard) and explain this was the first phone. Ask students what design they think comes next in time and why. Then tape your Phone #2 next to Phone #1. Ask students what they notice that's different about this design – and how it's better at helping people communicate. Continue until you've discussed all the phones and assembled the complete correct timeline as a class.

PHONE	QUESTIONS	POSSIBLE RESPONSES
	<p>This was one of the first phones. People had to ask an “operator” to make the call for them.</p>	<p>--</p>
	<p>What did the engineers change in this design?</p>	<p>It had a dial that people could use to make a call on their own.</p>
	<p>How did this change optimize the phone design - that is, make it better?</p>	<p>People didn’t have to ask an operator to make the call.</p>
	<p>What did the engineers change in this design?</p>	<p>You could talk and listen with one piece – the handle.</p>
	<p>How did this change optimize the phone design - that is, make it better?</p>	<p>People didn’t have to use two different parts: a mouthpiece to talk into and an earpiece to listen with.</p>
	<p>What did the engineers change in this design?</p>	<p>It had push buttons instead of a dial and a stretchy (expandable) cord.</p>
	<p>How did this change optimize the phone design - that is, make it better?</p>	<p>People could make their calls more quickly – and move around a little bit more.</p>

PHONE	QUESTIONS	POSSIBLE RESPONSES
	<p>What did the engineers change in this design?</p>	<p>It's the first “mobile” phone: you could move around while talking on the phone.</p>
	<p>How did this change optimize the phone design - that is, make it better?</p>	<p>People didn't have to be stuck in their homes to make a call.</p>
	<p>What did the engineers change in this design?</p>	<p>It was smaller and lighter than the first mobile phone.</p>
	<p>How did this change optimize the phone design - that is, make it better?</p>	<p>People didn't have to carry around a big and heavy mobile phone.</p>
	<p>What did the engineers change in this design?</p>	<p>It had a bigger screen and more things you could do (like take pictures).</p>
	<p>How did this change optimize the phone design - that is, make it better?</p>	<p>With the bigger screen, it was easier (and faster) for people to see what they were doing and to make calls, and they had more ways to communicate – like sending pictures to each other.</p>
	<p>What did the engineers change in this design?</p>	<p>It has a touchscreen and you can get on the internet, watch and share YouTube videos, etc.</p>
	<p>How did this change optimize the phone design - that is, make it better?</p>	<p>The big touchscreen and all the apps gave people even more and faster ways to “talk” to—and share things—with each other.</p>

14.

Bring your students' attention to the engineering design cycle. Engage students in a discussion about how technological and biological evolution are the same and different using the questions below and on the following pages.

-  **When engineers designed the first phone, do you think they believed it would last forever? How do you think they felt when they saw later designs?**
 -  Responses will vary. Encourage students to explain their reasoning.
-  **When we talked about the evolution of the horse, we saw that it was changing over time. What did those changes make the horse better at doing?**
 -  The changes made the horse better at surviving.
-  **When we talked about the evolution of the phone designs, we saw that they were changing over time. What did those changes make the phone better at doing?**
 -  The changes made the phone better at helping people talk to (communicate with) each other.
-  **Both the horse and the phone changed over time and got better at what they needed to do. Let's look at the engineering design cycle. In what part of the cycle do engineers work at making their designs better?**
 -  In the OPTIMIZE phase.

Talk About This



- ⚙️ **So, the evolution of the horse and the evolution of the phone technology are the SAME because both involved OPTIMIZING – making something better over time. But looking at the design cycle, do you think there are any big ways that the evolution of the horse and the evolution of the phone technology are different?**
 - ⚙️ Responses will vary. (The following questions get at this topic further).
- ⚙️ **In the evolution of the horse, its legs got longer and its teeth got taller. Why did these changes happen? Was it because one day a horse decided it needed to be faster to get away from predators?**
 - ⚙️ No, the horse didn't decide to evolve. The evolution of the horse happens through natural selection. That means: by chance (TEACHERS: again, if you have covered genetic mutation in class, that term could be used here), some horses might have had slightly taller teeth. They were more likely to survive and have babies, who also had taller teeth. And over very long times, horses' teeth very slowly got taller because that helped them eat the grass better and survive.
- ⚙️ **In the evolution of the phone, why did the design changes happen?**
 - ⚙️ Because humans decided to make the changes. People had things they wanted the phone to be able to do, like call someone faster, or take pictures and share them. Then engineers designed a new phone to meet that need.



Talk About This Cont'd

- ⚙️ **Let's look again at the engineering design cycle. In what part of the cycle do engineers figure out what people need and what the problem is?**
 - ⚙️ In the DEFINE phase.
- ⚙️ **Explain: So, the evolution of the horse and the evolution of the phone technology are DIFFERENT from each other because only the phone designs go through the DEFINE phase – figuring out what the problem is and what people need.**
- ⚙️ **There's another way that these two kinds of evolution are very different. Do you remember how long it took the horse to evolve to the ones we see today?**
 - ⚙️ It took about 50 million years.
- ⚙️ **How long did it take for the phone design to evolve from that first phone all the way to the Dax's smartphone? [Refer to the resource Timeline Clues, which shows the years each new phone was designed.]**
 - ⚙️ The oldest phone that Alejandra found was from 1907. That's only a little over 100 years ago.
- ⚙️ **Explain: 100 years compared to 50 million years! That's a big difference! So, the evolution of the horse and the evolution of the phone technology are DIFFERENT from each other because they happen over very different amounts of time.**



15.

To help students get a better feel for the different time spans, here are two options (you can use one or both!:

Explain to students: *Imagine that we squished the evolution of the horse into 10 years. Then the evolution of the phone would happen in about 10 minutes!*

OR

Use the resource **Dot Timelines**. Show students the sheet of paper with one dot and explain that the dot represents how long it took phone designs to evolve. Then have students spread all the other sheets of paper out, in rows, on the classroom floor. Explain that all those dots represent, in comparison, how long it took for the horse to evolve to what it looks like today.

16.

Recap how the evolution of the horse and the phone design are like each other and different from each other. Write a recap on your blackboard/whiteboard so students can refer to it **throughout the rest of the lesson**.

How are the evolution of the phone and the horse the same?

⚙️ Both OPTIMIZE (get better at meeting needs)

How are the evolution of the phone and the horse different?

⚙️ Humans decide to change phone designs (they DEFINE the problem).

⚙️ Changes in the phone happened over a much shorter time.



17.

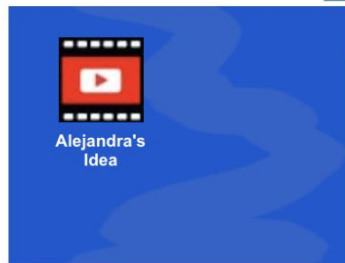
Remind students: *Now Alejandra can see how the phone design changed over time, making it better at helping people talk to each other. Let's see what happens next.*

If you want, you can tell students: *To get ready: if you have a phone at home, open up an app – such as a map, music, or game app – and try drawing a picture of it.*

Design Challenge - A Better App: Steps

Design Challenge
A Better App

1.



**"I BEGAN TO WONDER:
WHAT COULD I DESIGN
THAT WOULD HELP
BRING US TOGETHER
AND COMMUNICATE
BETTER?"**

Alejandra in the Year 2108

At goteems.com/lessons/from-the-future, scroll down to Resource Block Three. Project this screen for the class.

2.

Click on the resource **Alejandra's Idea** to open the 1-minute video. The video will start automatically. Watch and listen to the story as a class.

- 3.** When the video ends, close the viewer. To check understanding, you can ask students the questions below.

- ⚙️ **What feelings did Alejandra think she and Dax had in common?**
 - ⚙️ They were both worried about starting ninth grade, making friends, avoiding bullies, and finding their way around.
- ⚙️ **What did this lead Alejandra to think about other students her age, in her own time?**
 - ⚙️ She wondered if there might be more students her age who were worried about starting high school.
- ⚙️ **What idea did Alejandra have to help all these people communicate with each other?**
 - ⚙️ She had the idea of designing an app for the “communication devices” (phones) of her time.
- ⚙️ **How was Alejandra thinking like an engineer?**
 - ⚙️ Responses will vary. (For example: thinking about user needs, brainstorming a solution, etc.) Encourage students to share a variety of answers and explain their reasoning.
- ⚙️ **We’ve all probably felt worried about starting something new. Starting a new grade, like Alejandra and Dax, might make you nervous because it would mean doing lots of things you’ve never done before – especially if it’s in a different school building. Is there a time when you started something new, like moving from 5th to 6th grade, and felt worried?**
 - ⚙️ Responses will vary. [If you feel that your students would not be comfortable sharing these feelings, you might want to share an experience about starting something new as a teacher and the feelings you had about that.]

4. Explain to students: *Alejandra, in her future world of 2108, wants to design an app for new ninth graders. We can think of this as the next step in the evolution of phone designs – something that makes it better at helping people communicate (talk with) each other. Back here in our time, we’re going to design an app for fifth graders who have worries about starting sixth grade. And to help us through that, we can look back at our class engineering design cycle.*
5. Start a class discussion about the first phase of the engineering design cycle: **Define**. Encourage students to think about the different parts of defining the problem. A crucial part of this phase is to figure out what the user wants and needs.
6. Organize the class into design teams of two or three students each. Make sure to end up with an **EVEN** number of teams (because teams will be paired up later). Provide each team with a printed copy of the resources **Design Report**. Also provide each team with a printed copy of **ONE** of the Fifth-Grader Stories: **Olivia, Skylar, Gabriel, Jayden, Theodore, or Camila**. If possible – if you have enough groups – make sure all six stories get used.
7. Have each team read their Fifth-Grader Story. Team should identify the fifth-grader’s user needs: that is, what would this fifth-grader want an app to do to make sixth grade less scary and confusing? Have students write these user needs in their **Design Report** (under User Needs).

- 8.** Start a class discussion about the second phase of the engineering design cycle: **Develop**. Encourage students to think about the different parts of developing a solution: they should do research (get expert advice), brainstorm a design, and create a prototype. As users of apps themselves, teams can view themselves as experts about the kinds of things that apps can do and how well the apps do it.

- 9.** Now each design team is ready to brainstorm designs for the app. What features should it include? Students should let ideas flow and build on each other's thoughts. From the many ideas, each team has to choose three main features for the app (three things it can do). Have them write down the three solutions they choose in their **Design Report** (under App Features).

- 10.** Next, students can sketch a prototype. Provide each team with a printed copy of the resource **App Sketch #1**. Tell students to sketch their three app features on the three phones (one feature per phone) on the **App Sketch #1** handout. As an example of what sketching a feature can look like, give a printed copy of the resource **App Sample** to each team. Three features (things you can do) with this app are: finding the lunch menu, chatting with friends, and locating drinking fountains.

- 11.** Start a class discussion about the third phase of the engineering design cycle: **Optimize**. Encourage students to think about the different parts of optimizing the solution: testing the prototype, getting feedback, and communicating their solution. Although they aren't able to test the prototype, they can get feedback, improve the design, and communicate their solution.

12. Give every student a printed copy of the resource **Feedback Report**.
13. Now, pair each team with another team. (Let's call them Team A and Team B.)
14. Have Team A and Team B swap their **Design Reports**. Give students a few minutes to look at the other team's Design Report. Then they're ready to start giving feedback.
 - ⚙ In their **Feedback Reports**, each student on Team A completes "Step 1 Give Feedback" for Team B's design. At the same time, each student on Team B completes "Step 1 Give Feedback" for Team A's design.
 - ⚙ In their **Feedback Reports**, each student (on both teams) completes "Step 2 Reflect" based on their own experiences with apps.
 - ⚙ In their **Feedback Reports**, each student on Team A uses their reflections from Step 2 to complete "Step 3 Give MORE Feedback" for Team B's design. Each student on Team B does the same for Team A's design.
 - ⚙ Team A and Team B swap their **Design Reports** back and also swap all their **Feedback Reports**.
15. Teams should now separate back to their own groups. Each team should have their own Design Report and the other team's feedback.



- 16.** Have teams review the feedback they got and summarize it in their **Design Report** in the section “Feedback on Our App.” Then have teams brainstorm ideas about how they will use the feedback to improve their app design. This should be recorded in their Design Report in the section “Make It Better.”
- 17.** Give each group a copy of the resource **App Sketch #2**. Tell students to sketch their three improved app features on the three phones (on feature per phone) on the **App Sketch #2** handout.
- 18.** Have each team communicate to the class about how they improved (optimized) their app design. To help structure the communication, you could write these sentence starters on the board:
- ⚙ At first, we designed our app to...
 - ⚙ We got feedback about...
 - ⚙ So we improved...
- 19.** To end the lesson, have students reflect on what they learned about engineering design throughout the unit. You can have them write or discuss these questions aloud.
- ⚙ How did defining, developing, and optimizing work as phases of the app design process?
 - ⚙ How are these phases like and unlike biological evolution?
 - ⚙ How has your app design helped phones evolve: that is, how does it improve how people communicate with each other?
 - ⚙ In the evolution of phones, what do you engineers will design next? And how long might it take for that to happen?