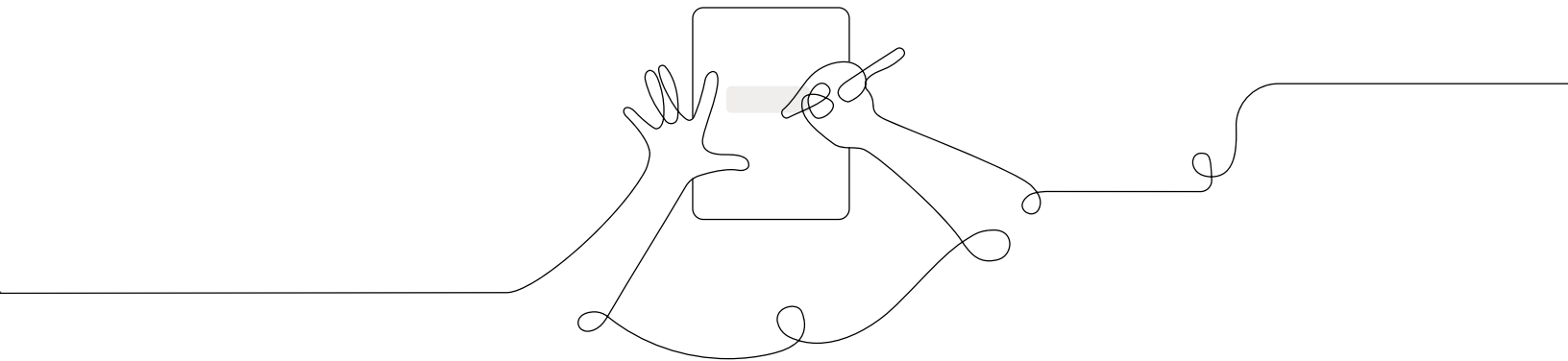


Participant Notebook

Grade 6: Thermal Energy
Guided Unit Internalization with @Home
Resources



Unit Guide resources

Once a unit is selected, select **JUMP DOWN TO UNIT GUIDE** in order to access all unit-level resources in an Amplify Science unit.

Planning for the unit

Unit Overview	Describes what's in each unit, the rationale, and how students learn across chapters
Unit Map	Provides an overview of what students figure out in each chapter, and how they figure it out
Progress Build	Explains the learning progression of ideas students figure out in the unit
Getting Ready To Teach	Provides tips for effectively preparing to teach and teaching the unit in your classroom
Materials and Preparation	Lists materials included in the unit's kit, items to be provided by the teacher, and briefly outlines preparation requirements for each lesson
Science Background	Adult-level primer on the science content students figure out in the unit
Standards at a Glance	Lists NGSS Standards (Performance Expectations, Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts), Common Core State Standards for English Language Arts, and Common Core State Standards for Mathematics

Teacher references

Lesson Overview Compilation	Lesson Overview of each lesson in the unit, including lesson summary, activity purposes, and timing
Standards and Goals	Lists NGSS (Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts) and CCSS (English Language Arts and Mathematics) standards in the unit, explains how the standards are reached
3-D Statements	Describes 3-D learning across the unit, chapters, and in individual lessons
Assessment System	Describes components of the Amplify Science assessment system, identifies each 3-D assessment opportunity in the unit
Embedded Formative Assessments	Includes full text of formative assessments in the unit
Articles in This Unit	Summarizes each unit text and explains how the text supports instruction
Apps in This Unit	Outlines functionality of digital tools and how students use them (in grades 6-8)
Flexextensions in This Unit	Summarizes information about the Hands-On Flexextension lesson(s) in the unit

Printable resources

Coherence Flowcharts	Visual representation of the storyline of the unit
Copymaster Compilation	Compilation of all copymasters for the teacher to print and copy throughout the unit
Flexextension Compilation	Compilation of all copymasters for Hands-on Flexextension lessons throughout the unit
Investigation Notebook	Digital version of the Investigation Notebook, for copying and projecting
Multi-Language Glossary	Unit vocabulary words in 10 languages
NGSS Information for Parents and Guardians	Information for parents about the NGSS and the shifts for teaching and learning
Print Materials (8.5" x 11")	Digital compilation of printed cards (i.e. vocabulary cards, student card sets) provided in the kit
Print Materials (11" x 17")	Digital compilation of printed Chapter Questions and Key Concepts provided in the kit



Unit Map

Which heating system will best heat Riverdale School?

In their role as student thermal scientists, students work with the principal of a fictional school, Riverdale School, in order to help the school choose a new heating system. They compare a system that heats a small amount of water with one that uses a larger amount of cooler groundwater. Students discover that observed temperature changes can be explained by the movement of molecules, which facilitates the transfer of kinetic energy from one place to another. As they analyze the two heating system options, students learn to distinguish between temperature and energy, and to explain how energy will transfer from a warmer object to a colder object until the temperature of the two objects reaches equilibrium.

Chapter 1: What is happening when the air in the school gets warmer?

Students figure out: If the heating systems make the school's air warmer, it is because they increase the average speed of the molecules of the school's air. Things are made of molecules (or other types of atom groups). When a thing gets hotter, its molecules are moving faster. When a thing gets colder, its molecules are moving slower. Temperature is a measure of the average speed of the molecules of a thing.

How they figure it out: They investigate the movement of food coloring in warm and cool water. They investigate molecular movement and temperature in the Sim. They read about the idea of absolute zero. They create visual models showing the difference between a substance when it is warmer and cooler.

Chapter 2: What causes the air molecules inside the school to speed up?

Students figure out: The air molecules inside the school will speed up if energy is transferred to them. When a thing gets hotter, its molecules are moving faster and have more kinetic energy. When a thing gets colder, its molecules are moving slower and have less kinetic energy. When two things are in contact, their molecules collide, and kinetic energy transfers from the faster-moving molecules to the slower-moving molecules. Energy isn't created or destroyed. Therefore, as energy transfers, it increases in one part of the system as it decreases in another part of the system. The molecules of a system will transfer energy until the system reaches a stable state known as equilibrium, in which all of the molecules are moving at about the same speed. Both heating systems should work to heat the school's air because both have water that starts at a higher temperature than the starting temperature of the school's air, so energy will transfer to the air.

How they figure it out: They observe a video of an investigation in which a container of warm water heats the air around it, and they explore one thing warming another in the Sim. They read "How Air Conditioning Makes Cities Hotter" and examine molecule collisions during energy transfer in the Sim. They also model energy transfer using tokens in a physical model. They create sentences using key vocabulary and make visual models explaining energy transfer. They play a thermal energy card game to review key ideas.

Chapter 3: Which heating system will warm the air in the school more?

Students figure out: The groundwater system will heat the school more because it uses so much more water than the other system, even though its water is not as warm as in the other system. For things at the same temperature, the thing with more molecules has more total kinetic energy (thermal energy) than the thing with fewer molecules. When a thing gains or loses energy, the energy gained or lost is divided among all the molecules of the thing.



How they figure it out: They investigate energy transfer with different volumes of water. They read about size of objects (numbers of molecules) and energy transfer in the article “Thermal Energy Is NOT Temperature.” Students test energy transfer using objects of different sizes in the Sim. They make a final model explaining energy transfer and write an explanation of which heating system is better for the school and why.

Chapter 4: Students apply what they learn to a new question—Why wasn’t the water pasteurized?

Kits for pasteurizing water were distributed to help victims of a natural disaster heat water and make it safe to drink, but some people still got sick. Was this because of a problem with the kits or because some people did not follow the instructions? Students analyze evidence about temperature, mass, and energy transfer in order to make their arguments. They engage in oral argumentation in a student-led discourse routine called a Science Seminar and then write final arguments.



Progress Build

Each Amplify Science Middle School unit is structured around a unit-specific learning progression, which we call the Progress Build. The unit's Progress Build describes the way students' explanatory understanding of the unit's focal phenomena is likely to develop and deepen over the course of a unit. It is an important tool in understanding the structure of a unit and in supporting students' learning: it organizes the sequence of instruction (generally, each level of the Progress Build corresponds to a chapter), defines the focus of assessments, and grounds the inferences about student learning progress that guide suggested instructional adjustments and differentiation. By aligning instruction and assessment to the Progress Build (and therefore to each other), evidence about how student understanding is developing may be used during the course of the unit to support students and modify instruction in an informed way.

The *Thermal Energy* Progress Build consists of three levels of science understanding. To support a growth model for student learning progress, each level encompasses all of the ideas of prior levels and represents an explanatory account of unit phenomena, with the sophistication of that account increasing as the levels increase. At each level, students add new ideas and integrate them into a progressively deeper understanding of how objects in contact can heat up and cool down. Since the Progress Build reflects an increasingly complex yet integrated explanation, we represent it by including the new ideas for each level in bold.

Prior knowledge (preconceptions). At the start of the *Thermal Energy* unit, middle school students will have ideas about hot and cold that draw heavily from sensory experiences. Based on experiences such as opening a freezer door or feeling a cold wind, students may believe that cold is a substance that can be transferred to warmer objects. Most students at this age will not distinguish between temperature and thermal energy. However, when faced with two objects in contact at different temperatures, most will have a productive notion that some change will occur due to the temperature difference.

Most students will have been exposed to the idea that objects are made of molecules (which themselves are composed of atoms). However, students are likely to have some alternate conceptions or partial conceptions about molecules; for example, they may think that the characteristics of each molecule mirror the characteristics of the object. If your students have had the *Harnessing Human Energy* unit, or another unit about energy, they may be familiar with kinetic energy as the energy of motion, but they may not have considered kinetic energy at the molecular scale. Thus, the idea of a motionless object being composed of molecules with kinetic energy might initially be confusing. The *Thermal Energy* Progress Build is structured to utilize all of these experiences and insights that students possess in order to refine and build upon students' understanding.

Progress Build Level 1: The temperature of an object is related to the kinetic energy of its molecules, which increases as the speed of the molecules increases.

Molecules move and change speed. Temperature is a measure of kinetic energy, which is the energy of the movement of the molecules. Hotter things are made up of faster-moving molecules, which have more kinetic energy. Colder things are made up of slower-moving molecules, which have less kinetic energy. Changes in temperature are the result of molecules changing kinetic energy.

Progress Build Level 2: Warmer objects transfer energy to cooler objects when they are in contact.

Molecules move and change speed. Temperature is a measure of kinetic energy, which is the energy of the movement of the molecules. Hotter things are made up of faster-moving molecules, which have more kinetic energy. Colder things are made up of slower-moving molecules, which have less kinetic energy. Changes in temperature are the result of



molecules changing kinetic energy. **When things are in contact, the faster-moving molecules of the hotter thing transfer kinetic energy to the slower-moving molecules of the colder thing. The transfer of kinetic energy causes faster-moving molecules to slow down and slower-moving molecules to speed up until all of the molecules are moving at about the same speed.**

Progress Build Level 3: The size of the objects in contact affects the amount of energy transfer between them and the amount of temperature change.

Molecules move and change speed. Temperature is a measure of kinetic energy, which is the energy of the movement of the molecules. Hotter things are made up of faster-moving molecules, which have more kinetic energy. Colder things are made up of slower-moving molecules, which have less kinetic energy. Changes in temperature are the result of molecules changing kinetic energy. When things are in contact, the faster-moving molecules of the hotter thing transfer kinetic energy to the slower-moving molecules of the colder thing. The transfer of kinetic energy causes faster-moving molecules to slow down and slower-moving molecules to speed up until all of the molecules are moving at about the same speed. **Larger things are made of more molecules than smaller things (in circumstances where other factors, such as material and phase, are equal). Changes in temperature are affected by the number of molecules of a system (e.g., an object, or two objects in contact) because kinetic energy is distributed among all of the molecules of a system. At any given molecular speed, an object made of more molecules has more total kinetic energy than a similar object made of fewer molecules; therefore, larger objects have more total kinetic energy than smaller objects at the same temperature. In order to change the average speed of more molecules, more total kinetic energy must transfer into or out of a system. So, for any given transfer of kinetic energy, larger things experience less change in temperature than smaller things.**

Guided Unit Internalization Planner

Part 1: Unit-level internalization

Unit title:

What is the phenomenon students are investigating in your unit?	
Unit Question:	Student role:
By the end of the unit, students figure out ...	
What science ideas do students need to figure out in order to explain the phenomenon?	

Unit Guide Document

Unit Map

Lesson Overview
Compilation

Unit Map

Progress Buld

Guided Unit Internalization

Part 1: Unit-level internalization

Unit title: Thermal Energy

What is the phenomenon students are investigating in your unit?

Students work with the principal of Riverdale School, a fictional school, in order to help choose a new heater system.

Unit Question:

Why do things change temperature?

Student role:

Student thermal scientists

By the end of the unit, students figure out ...

The groundwater system will heat the school more because it uses so much more water than the other system, even though its water is not as warm as in the other system. For things at the same temperature, the thing with more molecules has more total kinetic energy (thermal energy) than the thing with fewer molecules. When a thing gains or loses energy, the energy gained or lost is divided among all the molecules of the thing.

What science ideas do students need to figure out in order to explain the phenomenon?

Temperature of an object is related to the kinetic energy of its molecules. Changes in temperature are the result of molecules changing in kinetic energy. When things are in contact, the faster-moving molecules of the hotter thing transfer kinetic energy to the slower-moving molecules of the colder thing. At any given molecular speed, an object made of more molecules has more total kinetic energy than similar object made of fewer molecules; therefore, larger objects have more total kinetic energy than smaller objects at the same temperature. In order to change the average speed of more molecules, more total kinetic energy must be transferred into or out of a system. So, for any given transfer of kinetic energy, larger things experience less change in temperature than smaller things.

Thermal Energy @Home Lesson Index

The Amplify Science@Home Units are versions of Amplify Science units adapted for use in a remote learning or hybrid learning situation. To help you plan instruction, below we have listed the @Home Lessons alongside the Amplify Science unit's Lesson(s) from which they come.

Index: @Home Unit Lessons and corresponding *Thermal Energy* Lessons

@Home Lesson	Adapted from Amplify Science <i>Thermal Energy</i>
@Home Lesson 1	Lesson 1.2 and 1.3
@Home Lesson 2	Lessons 1.4
@Home Lesson 3	Lessons 2.1
@Home Lesson 4	Lesson 2.2
@Home Lesson 5	Lesson 2.3
@Home Lesson 6	Lesson 2.4
@Home Lesson 7	Lesson 2.5
@Home Lesson 8	Lesson 3.1
@Home Lesson 9	Lesson 3.2
@Home Lesson 10	Lesson 3.3 and 3.4
@Home Lesson 11	Lessons 4.1
@Home Lesson 12	Lessons 4.2 and 4.3
@Home Lesson 13	Lesson 4.4

The student sheets and packets used in @Home units are original or modified versions of the unit's Amplify Science Investigation notebook pages or copymasters. When necessary, new pages were also created. In the following table we have outlined the @Home Student Sheet and Packet page titles and their origins.

Index: @Home Student Sheets/Packets and corresponding *Thermal Energy* materials

@Home Lesson	Student Sheet/Packet page title	Investigation Notebook page, copymaster, or print material
1	Thermal Energy Glossary	Pgs. 118-119
1	Simulating Hot and Cold Water	Pg. 12
2	"Absolute Zero"	Lesson 1.3 Copymaster
2	"How to Find an Average"	Lesson 1.4 Copymaster
2	Calculating the Average Speed of Molecules	From NB page 17
2	Modeling Differences in Temperature	From NB pages 18 and 19
2	Thermal Energy @Home Science Wall	New, based on Classroom Wall materials
3	Visualizing Motion as Energy	Modified, based on Pg. 27
3	Word Relationships	Modified, based on Pg. 28
4	"How Air Conditioners Make Cities Hotter"	Lesson 2.2 Copymaster
5	Simulating Temperature Change	Modified, based on Pg. 35
5	Revisiting "How Air Conditioners Make Cities Hotter"	Pg. 36
6	Investigating Energy Transfer	Pg. 41
6	Using the Energy Model	New
6	Energy Model Graphic Organizer	Lesson 2.4 Copymaster
7	Word Relationships	Pg, 49
7	Modeling Temperature Change	Lesson 2.5 Copymaster
7	Thermal Energy @Home Science Wall	New, based on Classroom Wall materials
8	"Thermal Energy is NOT Temperature"	Lesson 3.1 Copymaster
9	Revisiting "Thermal Energy is NOT Temperature"	Pg. 72
9	Revisiting the Energy Model	Pgs. 73-74
9	Revisiting the Energy Model Graphic Organizer	Lesson 3.2 Copymaster
10	Solving the Heating System Question	Modified, based on Pg. 80
10	Advising the Principal	Pg. 90

10	Thermal Energy @Home Science Wall	New, based on Classroom Wall materials
11	Water Emergency on Louis Island	Pg. 97
11	Science Seminar Reference Cards	Lesson 4.1 Copymaster
11	Science Seminar Evidence Cards	Lesson 4.1 Copymaster
11	Science Seminar Evidence Cards (continued)	Lesson 4.1 Copymaster
11	Question and Claim Cards	Lesson 4.1 Copymaster
11	Analyzing the Evidence	Pg. 99
11	Sorting Evidence	Pg. 100
12	Argumentation Sentence Starters	New, based on print materials
12	Writing a Scientific Argument	Pgs. 112-114
13	Written Response Question #1	Lesson 4.4 Copymaster
13	Written Response Question #2	Lesson 4.4 Copymaster

Day _____			
Minutes for science: _____		Minutes for science: _____	
Instructional format: <input type="checkbox"/> Asynchronous <input type="checkbox"/> Synchronous		Instructional format: <input type="checkbox"/> Asynchronous <input type="checkbox"/> Synchronous	
Lesson or part of lesson:		Lesson or part of lesson:	
Mode of instruction: <input type="checkbox"/> Preview <input type="checkbox"/> Review <input type="checkbox"/> Teach full lesson live <input type="checkbox"/> Teach using synchronous suggestions <input type="checkbox"/> Students work independently using: <input type="checkbox"/> Printed @Home Slides <input type="checkbox"/> Digital @Home Slides <input type="checkbox"/> @Home Videos		Mode of instruction: <input type="checkbox"/> Preview <input type="checkbox"/> Review <input type="checkbox"/> Teach full lesson live <input type="checkbox"/> Teach using synchronous suggestions <input type="checkbox"/> Students work independently using: <input type="checkbox"/> Printed @Home Slides <input type="checkbox"/> Digital @Home Slides <input type="checkbox"/> @Home Videos	
Students will...	Teacher will...	Students will...	Teacher will...

<p>Look at the <i>Students will</i> columns. What are students working in the lesson(s) above that you could collect, review, or provide feedback on? See Some Types of Written Work in Amplify Science to the right for guidance.</p> <p>If there isn't a work product listed above, do you want to add one? Make notes below.</p>	<p>Some Types of Written Work in Amplify Science</p> <ul style="list-style-type: none"> • Daily written reflections • (6-8) Homework tasks • (K-5) Investigation notebook pages • Written explanations (typically at the end of Chapter) • Diagrams • Recording pages for Sim uses, investigations, etc 	
<p>How will students submit this work product to you? See the Completing and Submitting Written Work tables to the right for guidance on how students can complete and submit work.</p>	<p>Completing Written Work</p> <ul style="list-style-type: none"> • Plain paper and pencil (videos include prompts for setup) • (6-8) Student platform • Investigation Notebook • Record video or audio file describing work/answering prompt • Teacher-created digital format (Google Classroom, etc) 	<p>Submitting Written Work</p> <ul style="list-style-type: none"> • Take a picture with a smartphone and email or text to teacher • Through teacher-created digital format • During in-school time (hybrid model) or lunch/materials pick-up times • (6-8) Hand-in button on student platform
<p>How will you differentiate this lesson for diverse learners? (Navigate to the lesson level on the standard Amplify Science platform and click on differentiation in the left menu.)</p>		

Multi-day planning, including planning for differentiation and evidence of student work

Day _____			
Minutes for science: _____ Instructional format: <input type="checkbox"/> Asynchronous <input type="checkbox"/> Synchronous		Minutes for science: _____ Instructional format: <input type="checkbox"/> Asynchronous <input type="checkbox"/> Synchronous	
Lesson or part of lesson: Mode of instruction: <input type="checkbox"/> Preview <input type="checkbox"/> Review <input type="checkbox"/> Teach full lesson live <input type="checkbox"/> Teach using synchronous suggestions <input type="checkbox"/> Students work independently using: <input type="checkbox"/> Printed @Home Slides <input type="checkbox"/> Digital @Home Slides <input type="checkbox"/> @Home Videos		Lesson or part of lesson: Mode of instruction: <input type="checkbox"/> Preview <input type="checkbox"/> Review <input type="checkbox"/> Teach full lesson live <input type="checkbox"/> Teach using synchronous suggestions <input type="checkbox"/> Students work independently using: <input type="checkbox"/> Printed @Home Slides <input type="checkbox"/> Digital @Home Slides <input type="checkbox"/> @Home Videos	
Students will...	Teacher will...	Students will...	Teacher will...

<p>Look at the <i>Students will</i> columns. What are students working in the lesson(s) above that you could collect, review, or provide feedback on? See Some Types of Written Work in Amplify Science to the right for guidance.</p> <p>If there isn't a work product listed above, do you want to add one? Make notes below.</p>	<p>Some Types of Written Work in Amplify Science</p> <ul style="list-style-type: none"> • Daily written reflections • (6-8) Homework tasks • (K-5) Investigation notebook pages • Written explanations (typically at the end of Chapter) • Diagrams • Recording pages for Sim uses, investigations, etc 	
<p>How will students submit this work product to you? See the Completing and Submitting Written Work tables to the right for guidance on how students can complete and submit work.</p>	<p>Completing Written Work</p> <ul style="list-style-type: none"> • Plain paper and pencil (videos include prompts for setup) • (6-8) Student platform • Investigation Notebook • Record video or audio file describing work/answering prompt • Teacher-created digital format (Google Classroom, etc) 	<p>Submitting Written Work</p> <ul style="list-style-type: none"> • Take a picture with a smartphone and email or text to teacher • Through teacher-created digital format • During in-school time (hybrid model) or lunch/materials pick-up times • (6-8) Hand-in button on student platform
<p>How will you differentiate this lesson for diverse learners? (Navigate to the lesson level on the standard Amplify Science platform and click on differentiation in the left menu.)</p>		

Suggestions for synchronous time

The following are some ideas for making the most of synchronous time with your students. As a general rule, the best way to use your synchronous time is to provide students opportunities to talk to one another, or to observe or visualize things they could not do independently.

Online synchronous time	Notes
<p>Online discussions: It's worthwhile to establish norms and routines for online discussions in science to ensure equity of voice, turn-taking, etc.</p> <p>Digital tool demonstrations: You can share your screen and demonstrate, or invite your students to share their screen and think-aloud as they use a Simulation or other digital tool.</p> <p>Interactive read-alouds: Screen share a digital book or article, and pause to ask questions and invite discussion as you would in the classroom.</p> <p>Shared Writing: This is a great opportunity for a collaborative document that all your students can contribute to.</p> <p>Co-constructed class charts: You can create digital charts, or create physical charts in your home with student input.</p>	

Amplify Science@Home resources reference

Use this guide to keep track of the different resources available for remote and hybrid learning.

Instructional materials: Click Remote and hybrid learning resources, then select your grade level from the dropdown menu. Select your unit.	
@Home Unit resources: These will appear when you select your unit.	
Teacher Overview	General information for teaching with @Home Units, planning information, chapter and lesson outlines
Lesson Index	Lists the original Amplify Science lessons associated with each @Home lesson, and the Investigation Notebook pages, copymasters, and print materials associated with the @Home Unit Student Sheets
Family Overview	Information to send home to families to help them support students with remote learning
Student lesson materials for @Home Units	Printable or digital lessons condensed to be about 30 minutes long. You can access compilations of all student materials for your unit, or select from individual lessons.
@Home Video resources: After selecting your grade level and unit, select the @Home Videos tab below your unit title.	
@Home Video links	Links to video lessons that include all activities from the original units. Lesson playlists are on YouTube, and they autoplay in a playlist form.
Additional remote and hybrid instructional materials: These can be accessed from the tabs below your unit title.	
Hands-on investigations support	Videos of every unit's hands-on activities (note, these videos also appear in the student lesson materials).
Read-aloud videos	Link to a YouTube playlist of read-aloud videos of all books in your unit.
Orientation and Tutorials: Click Remote and hybrid learning resources, then select your grade from the dropdown menu. Click Orientation and Tutorials. You'll not only find videos to help you use the resources, but also videos you can share with students and caregivers.	

[illegible]