This is a transcript of the video “Reflections ~ STEAM Education from Queensland”
While you are watching the video, you can use this transcript for your better understanding of the contents.



## Introduction by Tina (the navigator)

**0:08**

Hello, everyone! I’m Tina and I’m the navigator for today’s session. I usually work at TGG.
Today’s theme is about the reflection of light. There is a lot of light around us. There is sunshine, electric lights, flashlights, neon lights at night, and many other kinds of light.
What is light, actually? Where does light come from? What are the properties of light? Have you ever thought about these things? In today’s session, we will clarify the various aspects of light by doing experiments.
The lesson question we will think of in this session is how the nature of light is used in the technology of telephones. We can call people faraway and overseas with cell phones. Let’s think together why we can call people in faraway places, at the same time we will learn about the nature of light. Sounds interesting?
Let’s join the class in Queensland and think together.

Before starting the session, I will introduce some words in this session to help you warm up.

microwave, you try
microwave
Microwave light is used in cell phones.

electron, you try
electron
Electrons go around a nucleus.

periscope, you try
periscope
You can see things on the surface of the sea from inside a submarine using a periscope.

OK. Now you’re ready!
Let’s experience the seminar class in Queensland together! The first theme is “What is light?”

# Join the classroom in Queensland

**02:46**

Welcome to the Queensland classroom.

In the Queensland classroom, we learn differently.

We learn using lots of questions.

We learn using lots of activities.

And we learn together to solve the questions that I ask you.

Today, the lesson question I have for you is, “How is light used to make a telephone call from Japan to Australia?”

In order to answer this question, first we have to answer a few more questions.

The first question is, “What is light?”

Light is energy.

Light is energy that travels as a wave.

Light travels as a wave at 300,000 kilometers every second.

That means seven and a half times around the earth every second.

That’s amazing.

## What is light? / Types of light?

**04:11**

The teacher explains what light is. It's a very important point, so let's check it out.
·Light is energy.
·Light travels at 300,000 km per second as a wave.
·It travels about 7 1/2 laps around the earth per second.

Do you realize how fast light moves?
Let's go back to the class and watch the video more.

There are many different types of light.

Light can be radio waves.

Light can be microwaves.

Light can be infrared radiation.

Light can be visible light.

Light can be ultraviolet.

Light can be x-rays.

And light can also be gamma rays.

Bonnie, what can you see in this PowerPoint slide about telephones and light?

Well, it seems that phones make microwave light.

Very good.

Phones produce microwave radiation or microwave light.

The teacher mentions types of light here. When it comes to light, we usually imagine visible light, but there seem to be various other kinds of light.

There are many kinds of light that are not visible to our eyes. For example, the light used on the phone is microwave light. This light is invisible to the eye, but it has the same properties as visible light and is used in telephones.
Let's go back to class and watch the video more. Next, we will think about the question

“Where does light come from?”

Now, my second question to you is, “Where does light come from?”

Does anyone know where light actually comes from?

No.

Eva, where does light come from?

I think that light comes from the sun.

Very good.

Elias, where do you think light comes from?

I think light also comes from light bulbs in the ceiling.

Very good, but where does light come from inside the sun?

Where does light come from inside the light bulb?

Does anybody know?

I’ll show you.

Come with me.

So, my question to you was, “Where does light come from?”

Now, I’ll show you where light comes from.

Light comes from the atom.

When I excite the atom, when I give the atom energy, it produces light.

Are you ready?

Pretty cool?

Yes.

Mauve, what did you see?

When the chemicals were mixed, light was made.

Excellent.

So when the atom is excited, the atom will release the energy as light.

## Structure of atom

**08:11**

As for where light comes from, the teacher says it comes from atoms. Let's see what kind of structure the atom has.

Electrons go around the nucleus, which consists of protons and neutrons. This is the basic structure of atoms.

When atoms are excited, electrons have energy and light is created. Iron turns bright red when heated to a high degree. The heat excites atoms, and light and thermal energy are created.
The teacher was experimenting with activating atoms by mixing chemicals to create light. Light is created by the activation of atoms. Remember this.

So, the question I have for you is, "Where does light come from?"

Light comes from the atom.

But inside the atom.

Now, I want you in groups to look at your diagram and discuss "Where does light come from?"

## Where does light come from?

**09:35**

Where does light come from? Look at the diagram on the screen and think about this question.

Let's go back to class and listen to what students are thinking.

So, I can see that the low energy electron is not excited.

And I can see that the high energy electron is excited.

And the high energy electron is the one that produces the light.

So when the electron gets more energy, it begins to produce light.

And when it returns to its normal status, the light and the energy is released in the form of light.

Well done on answering the question, "Where does light come from?"

The next question I have for you is, "How does light behave?"

Now, you're going to do some active learning.

Active learning involves you doing demonstrations.

You doing practical activities.

And you, as a group, creating understanding.

Let's go and see how light behaves.

Welcome to the first inquiry station.

Here, I want you to investigate the question, "How does light behave?"

Good luck.

## The experiment regarding how light moves

**11:20**

Here, the teacher asks the students to do the first experiment regarding how light moves. We are verifying how the direction of light changes when it hits a mirror. Let's take a look at the experiment and learn about the behavior of light. And let's think about the relationship between light and telephones.

It looks like the light produced by this light box comes out and bounces off this mirror, producing a reflective wave.

This is called reflection.

That's really interesting, Ben.

And I can see that too in this diagram here.

A light wave being pointed towards a mirror and coming off as a reflected wave.

I wonder, if you move this would you be able to change the angle?

Let's have a look.

Wow, that's so cool.

It changes.

But the angle itself doesn't change, just the direction the reflected wave is pointed.

And we can see that again in the diagram.

That the angle a light wave is pointed at is always going to be the angle of the reflected wave.

So, I wonder how this relates to phone calls.

Well, maybe because the microwave light produced from your phone travels as a wave to the telephone tower and is reflected underground.

Wait, so does it go like up to the telephone tower and then come down through?

Yeah.

Wow.

Maybe it's reflected from the top.

That's so cool.

That's very interesting.

What did you think when you saw the experiment? The light changed the direction it bounced in when it hit the mirror. This is called reflection. The students were changing the angle of light they would shine on the mirror. When the light changed its angle of exposure, it changed direction in the same way. What we learned here is that light has the property of going in a straight line, and that the mirror can change its direction. The students were thinking about what this had to do with the phone. The light used on the phone was microwave light. This is also a kind of light. In other words, the microwave light used on the phone also moves in a straight line, but you can change its direction by pointing it at a mirror. The students understood that the microwave light hit the telephone tower, changed direction, and reached the other phone. The telephone tower plays the role of mirror, allowing you to call people in distant places.

Welcome to the second inquiry learning station.

Here, I also want you to investigate the question, "How does light behave?"

Good luck.

Let's move on to the second experiment. Now they will use a laser pointer to experiment with the movement of light. Let's take a look, thinking about what we will learn in this experiment.

I wonder what this is and why it's set up like this.

These mirrors are set up like this to demonstrate how, when light is pointed at a mirror, it reflects off and continues on its path and is not absorbed by the mirror.

For example, when I point this laser here, well, when it hits that surface, it reflects this way.

And when it hits this one, it reflects back towards you.

That's really cool.

It's like a different path.

Yeah.

Yeah, can I have a go?

Sure, just be careful not to point the laser pointer in anyone's eyes.

This shows that once a light hits a surface, it continues on its path.

And it isn't absorbed into the surface.

What did you think when you saw the experiment? It was an interesting experiment, wasn't it? Laser beams are also a type of light. When the laser light was reflected in the mirror, it changed direction. The mirror didn't absorb the light. The light was not weakened, and it moved in a different direction. Light changes direction because of mirrors, but its strength does not change.

Welcome to the third inquiry learning station.

Here, I also want you to investigate further the question, "How does light behave?"

Good luck.

Let's move on to the third experiment. How does light behave when it is passed through a tube? Let's take a look, thinking about what we will learn in this experiment.

Wow, when I point this laser beam into the tube, it bounces down the tube.

But why doesn't the light leave?

I'm not sure.

Well, I think it's because the tube is denser than the water inside.

And light has trouble moving from something less dense to something that's more dense.

And therefore, can't leave.

Wow, that's so interesting.

Then that makes so much sense too.

So I wonder how this relates to telephone calls?

Well, I think that the light behaves the same way as it does within these cables as it does within this tube.

Where the light reflects off the surfaces within the tube to travel along.

That makes sense.

But where are these tubes?

These tubes go all the way under the ocean to telephone towers throughout the world to make a phone call possible.

Wow, that's really interesting.

Really cool.

What did you think when you saw the experiment? Even in the tube, the light was moving in a straight line without being absorbed by the outer water. The light can continue traveling while repeatedly hitting a mirror inside the tube. The students were also wondering what this had to do with the phone. In fact, optical telephone signals are also carried through cables. The cables have the same structure as the tube used in the experiment. The light can proceed while reflecting through the cable.

Well done on learning from the inquiry stations.

Congratulations on learning about how light behaves.

Now, I want you to use that knowledge.

Use that understanding to answer our original lesson inquiry question.

How is light used to make a telephone call from Japan to Australia?

Discuss in your groups and come up with an answer.

Good luck.

## The role of light in telephone call

**18:55**

Here, the teacher asked the students the lesson question in the session. How is light used to make a telephone call from Japan to Australia? They will answer this question after learning about the nature of light. Let's think together.

You know what I think is crazy?

It's so cool but light actually travels at 300,000 kilometers a second.

Wow that's so cool.

So from here, it's traveling at 300,000 kilometers per second,

goes to the tower,

reflects through the tower and comes down

and does not escape and then goes across at 300,000 kilometers per second

and then back up to the tower.

And I'm pretty sure that's seven and a half laps around the earth.

Wow and like it's so cool how it doesn't escape through here.

It just bounces and bounces and bounces along and then all the way up to our phone.

Do you remember the second inquiry station we did?

The one with the laser?

Oh yeah, so showing that even when lights reflected it continues on its path.

So that would mean even after the light's been reflected off maybe a tower in Japan, it still continues on its path when it's in the cables.

Because like, it doesn't get absorbed, does it?

No, so it'll always make it to a tower in Australia and like the third station with the cables.

How do they keep the light in again?

Bouncing back and forth.

Oh, yeah.

And so, wait, the tubes run under the ocean so they can...

Yeah, because they can't escape from the tubes, remember?

Oh yeah.

So they just move the light from a tower here to a tower there, reflecting the light constantly.

I guess so.

Yeah, that's pretty cool.

How fast does it go again?

Sir said 300,000 kilometers per second, or seven and a half times around the earth in one second, which means it's getting there pretty fast.

Which is why when you talk to someone, you can basically talk in real time.

That makes so much more sense.

Yeah.

What is your answer? Is there anything different from the students' answers? The kind of light called microwave light is used in the phone. The direction of the light can be changed by mirrors. We also find that the light can pass through tubes like cables and we can communicate with people all over the world. Light is fast enough to go around the earth at seven and a half laps per second, so we can have real-time conversations without worrying about the distance between Japan and Australia.

Congratulations, guys, on understanding how light is used to make a telephone call from Japan to Australia.

Now I have a challenge for you.

In your groups, I want you to discuss how a periscope works.

How a periscope can be used to see above the ocean surface.

The challenge involves two mirrors.

How can you place two mirrors in this situation to see above the ocean surface?

I'd like you to now discuss this challenge in your groups.

## How does a periscope work?

**22:30**

The teacher presents the last challenge to the students here. It's about periscopes. Submarines in the sea can see the surface of the sea with periscopes. Keeping in mind the nature of the reflection of light, they will think about where to place the mirrors. Let's think together.

Ben, would you like to come on up and demonstrate the answer to the question, "How does a periscope work?"

My group and I thought that we should place two mirrors here, and then another one here.

This way, the light from the ship will travel in a straight line to the mirror.

Once it bounces off the mirror, it will change direction and travel in a straight line down to the next mirror.

From there, it will change direction and go in a straight line to the person looking into the periscope.

That way, they can see the light that has traveled through and see the ship.

Fantastic work, Ben.

Perfect, well done.

How was the last challenge? Did you answer correctly? It would have been easy if you understood the nature of light. If you couldn't answer well, listen to what the student was explaining again.

Congratulations, everyone, on a great inquiry lesson.

I hope you have learned about concepts of light.

How light behaves.

And how we use light in everyday life.

Well done.

## Closing by Tina (the navigator)

**24:18**

How was today's session? A phone is a tool for talking to someone who is far away. The nature of light is used in the telephone.
In today's session, you could learn that the world of physics is closely linked to daily life, and is put to practical use.
Today the students did experiments with light. They learned the nature of light by doing experiments, and explained it in their own words. It is very important to be able to explain results obtained from experiments and to make them understood by other people.
The students thought, acted, and looked for answers in teams by themselves. Teamwork is very important for their activities.
In this session, you will have gained knowledge that relates, not only to the physical properties of light, but also to the relationship between physics and daily life, the importance of teamwork, and how to give presentations. Please use what you learned in today's session for your future studies and work. Well done. See you later!