**Critical Learning**

- A wide range of technologies utilize the properties of light and colour.
- The fundamental concept of structure and function focusses on the relationship between the function of a human-made object and the form that the object takes.
- Sustainability is the concept of meeting the needs of the present without compromising the ability of future generations to meet their needs.

**Guiding Questions**

- How are the properties of light and colour applied to optical technologies in everyday life?
- What impact do these technologies have on society?

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**Curriculum Expectations**

**Scientific Investigation Skills and Career Exploration**

A1. demonstrate scientific investigation skills related to both inquiry and research in the four areas of skills; initiating and planning, performing and recording, analysing and interpreting, and communicating

- A1.9 analyze the information gathered from research sources for reliability and bias
- A1.10 draw conclusions based on inquiry results and research findings, and justify their conclusions
- A1.11 communicate ideas, plans, procedures, results, and conclusions orally, in writing, and/or in electronic presentations, using appropriate language in a variety of formats

**Physics: Light and Applications of Optics**

E1. analyse how properties of light and colour are applied in technology and how these technologies have an impact on society

- E1.1 analyze how additive and/or subtractive colour theory are applied in technologies used in everyday life [AI, C]
- E1.2 describe the role of selected optical technologies in the transmission of information, and analyse their impact on society [AI, C]

**Learning Goals**

Students will be able to:

- explain how an optical technology/device works using appropriate terminology
- graphically represent the workings of an optical device
- identify the impact of the optical device on society
- demonstrate investigation skills of performing and recording, analyzing and interpreting, and communication

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**Instructional Components and Context**

**Readiness**

- Collaborative norms and skills, e.g., taking roles, taking turns, disagreeing agreeably

**Materials**

- Images of appropriate optical devices/technology
- Poster materials

**Resources**

- Research material on various technologies
- Sample rubric
Information at the Speed of Light  Lesson 9

Minds On (Elicit, Engage)

Whole Group  Accessing Prior Learning
Students review their project logs, and refer to anchor charts and notes to revise and/or add any information. In an inside-outside circle, students use their project logs to respond to the following prompts:

• What is the technology (i.e., optical device) you have researched (selected in Lesson 1)?
• Share an interesting fact about your technology.
• How does your technology use light?
• Why is your technology important?
• How do we benefit from the technology?
• What do you still need to find out about your technology?

Rotate the circle for each prompt.

Whole Class  Reviewing Culminating Task and Previewing Learning Goals
Review components of the culminating task. Post a checklist of requirements students need to fulfill to complete the task.
Share the learning goals and guiding questions. Review any safety procedures pertinent to this lesson.

Action! (Explore, Explain)

Whole Class  Co-constructing Success Criteria
Share a number of samples of the culminating task, (e.g., posters, video clips, student work). In a Think-Pair-Share, students identify characteristics of the samples and suggest elements which could be revised or improved, (e.g., Is there anything that needs to be added? How could it be made more effective?). Debrief by inviting responses. Extend the discussion by listing the criteria, and co-constructing success criteria for the product. Post the criteria for students to reference.

Use the success criteria to create a rubric.

Discuss the importance of clear communication and sharing of findings in the scientific community. In a Think-Aloud, model using a RAFT strategy to clarify the task and help students plan.

Whole Class/Individual  Considering Benefits and Costs
Students research the benefits and costs of their technology. Under the headings, benefits and costs, list some guiding questions for students to consider: What problem does this technology solve? Is it a necessity for some people? Does the technology require a great deal of energy to produce? Does it involve any materials that require limited environmental resources? Invite students to generate additional questions and add to the lists.

Individually, students select questions from the lists that they would like to research, and jot them in their project logs.

Individual  Planning, Researching, and Drafting a Technology Poster
Students complete a RAFT for their project. Provide resources for researching their technology, and/or provide time for students to gather and select research material. Using their RAFTs, students read about their technology and take jot notes in their project log. They use the information, notes, and images to prepare a draft of their poster.

Small Groups  Conferencing to Improve Work
Students bring drafts of their poster to the conference. In round robin, students share and explain how their draft s meet the objectives of the RAFT. Use assessment criteria from the rubric to pose questions about students’ work and next steps.

Individual  Making Revisions Based on Feedback
Students make revisions to their posters based on feedback and complete final versions.

Pause and Ponder

AOL Circulate and monitor during the review of project logs, and use specific prompts to check for understanding.

AOL Use the learning goals and guiding questions as prompts to introduce the Action! and to provide students opportunities to reflect on learning throughout the lesson. See Metacognition Guide.

QuickTip When using samples to develop success criteria, use a few samples that vary in level of proficiency. Prompt students to note differences in the level of quality. Also, use the samples to identify elements that are not part of the assessment.

QuickTip Use RAFTs and drafts to inform instruction, e.g., provide clarification, form guided groupings.

QuickTip As an alternative, students may create online posters, e.g., Glogster.

QuickTip Form conferencing groups around common assessment points. Using group conferences (instead of individual conferences) is more time efficient and provides an informal rehearsal for students to communicate ideas about their work with others.

QuickTip Assigning roles for the gallery walk encourages purpose and focus during the task.
<table>
<thead>
<tr>
<th>Information at the Speed of Light</th>
<th>Lesson 9</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Consolidation (Elaborate, Evaluate, Extend)</strong></td>
<td><strong>Pause and Ponder</strong></td>
</tr>
<tr>
<td><strong>Whole Class ➔ Sharing Learning in Gallery Walk</strong></td>
<td><strong>A●L</strong> Use the exit card as an opportunity for students to reflect on learning. See Metacognition Guide.</td>
</tr>
<tr>
<td>Students display their posters around the room for a <em>gallery walk</em>. Use numbered heads to form three groups. Explain the role students in each of the three groups will take during the gallery walk:</td>
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<tr>
<td>- Role A: Present your poster to visiting students. Point out key information on the poster and address any questions they have.</td>
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<tr>
<td>- Role B: Point out one feature of the poster that is effective and share with the creator of the poster.</td>
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<tr>
<td>- Role C: Connect how the technology featured in the poster is like or unlike one other technology in the gallery walk.</td>
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<tr>
<td>Students engage in the gallery walk in their role. Rotate the groups so that students have participated in each of the three roles.</td>
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<tr>
<td><strong>Individual ➔ Reflecting on Learning</strong></td>
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<tr>
<td>On an <em>exit card</em>, students reflect on the following: What investigations and or research helped me understand my technology and how it works? How and why did it help?</td>
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</tbody>
</table>
Minds On (Elicit, Engage)

Inside-Outside Circles

Inside-Outside Circles is a strategy that structures a series of low-risk conversations between pairs of students. Half of the class forms an inside circle; these students face outward. The other half of the class forms an outside circle; these students face inward. Students engage in discussion with the student directly facing. On a signal the inside circle moves clockwise while the outside circle moves counterclockwise so that each student faces a new partner.


Safety Procedures

Teachers must model safe practices at all times and communicate safety expectations to students in accordance with school board and Ministry of Education policies and Ministry of Labour regulations. Teachers are responsible for ensuring the safety of students during classroom activities and also for encouraging and motivating students to assume responsibility for their own safety and the safety of others. Teachers must also ensure that students have the knowledge and skills needed for safe participation in science activities.

To carry out their responsibilities with regard to safety, it is important for teachers to have:

- concern for their own safety and that of their students
- the knowledge necessary to use the materials, equipment, and procedures involved in science safely
- knowledge concerning the care of living things – plants and animals – that are brought into the classroom
- the skills needed to perform tasks efficiently and safely

Students demonstrate that they have the knowledge, skills, and habits of mind required for safe participation in science activities when they:

- maintain a well-organized and uncluttered work space
- follow established safety procedures
- identify possible safety concerns
- suggest and implement appropriate safety procedures
- carefully follow the instructions and example of the teacher
- consistently show care and concern for their own safety and that of others

Various kinds of health and safety issues can arise when learning involves field trips. Out of school field trips can provide an exciting and authentic dimension to students’ learning experiences. They also take the teacher and students out of the predictable classroom environment and into unfamiliar settings. Teachers must preview and plan these activities carefully to protect students’ health and safety.

Action! (Explore, Explain)

Co-constructing Success Criteria

Co-constructing criteria is the process of working collaboratively with students to develop the criteria and indicators for successful demonstration of knowledge and/or skills related to learning goal.

See DI Assessment Guide and DI Assessment Cards.

Success Criteria

Success criteria provide students with a clear description of what successful attainment of learning goals looks like. When students know and understand the success criteria, they are more likely to have a clearer picture of the targeted learning, and know what they need to do to be successful. Developing success criteria early in a unit or task, encourages students to actively monitor and self-regulate their own learning as they are developing and practising new knowledge and skills.

When developing criteria:

- describe observable behaviours in clear, detailed, student friendly language
- create descriptions which allows for a range of performance
- ensure that the list of criteria is manageable
- engage students in the development process (co-construction) – this encourages a shared understanding of the criteria, gives students a greater sense of control, and initiates students in the use of specific language which describes their learning

When using success criteria:

- post the criteria, e.g., on an anchor chart, and refer to it when discussing learning goals and providing feedback
- invite students to discuss their learning and performance, making specific references to the success criteria
- develop other assessment tools, e.g., checklists, rubrics that are based on the assessment criteria, and make explicit for students the connections
- use anonymous samples of work, and engage students in analysing and critiquing the samples, using the one of more of the success criteria
- provide multiple opportunities for students to analyse and critique their own work, make adjustments, if needed, and set goals and next steps

See DI Assessment Guide and DI Assessment Cards.

See Metacognition Guide.
Think-Pair-Share

Bennett and Rolheiser (2001) describe think-pair-share as “one of the simplest of all the tactics” (page 94). As pointed out by Bennett and Rolheiser and Think Literacy (page 152), students require skills to participate effectively in Think-Pair-Share, e.g.,

- active listening
- taking turns
- asking for clarification
- paraphrasing
- considering other points of view
- suspending judgement
- avoiding put-downs

These skills can be modelled and explicitly taught. During group work, teachers can provide oral feedback and reinforce expectations.

Bennett and Rolheiser (2001) note additional considerations:

- the level of thinking required in a think-pair-share
- accountability and level of risk, e.g., are all students expected to share with the whole group? (page 94).

See Think Literacy Cross-Curricular Approaches, Grades 7-12, pages 152-153.


RAFT

RAFT (Role, Audience, Format, Topic) or RAFTS (Role, Audience, Format, Topic, Strong Verb) is a graphic organizer used for planning. Students use this tool to explore the role they will take on as creators, the audience they will address, the varied formats for their product, and the topic. A RAFT establishes a context for writing by focusing on the dynamic connections between author, audience, topic, form, and purpose that are at the heart of communication. As with other graphic organizers, RAFT provides a framework to consider the various components (i.e., Role, Audience, Format, and Topic) as well as the relationships between them. RAFT can be used as a planning tool for media, written, and oral communication.

See Student Success DI Package 2007, DI Cue Cards: Structures – RAFTs

See Think Literacy Subject-Specific Examples : Language/English, Grades 7-9, Generating Ideas: Setting the Context, pages 32-37

See RAFT with Question Prompts.

Think-Aloud

A Think-Aloud is an instructional scaffold that models thinking processes, making the invisible visible. In a think-aloud, the teacher verbalizes how effective readers process the text, e.g., by monitoring comprehension and using strategies to construct meaning. While teachers can think aloud at any point in an instructional sequence, think-alouds are frequent during the modelling phase of the gradual release model and during read-alouds.

See Think Literacy Subject-Specific Examples : Language/English, Grades 7-9, Engaging in Reading: Reading Between the Lines/ Inference, page 3.

A think-aloud is, therefore, a form of explicit instruction that requires teachers to be aware of their own thinking processes and that helps student think about their thinking. Developing metacognitive awareness is an important aspect of learning.

See Metacognition Guide.

Model

Modelling is a component of explicit instruction that is particularly helpful for struggling learners. According to the gradual release of responsibility model for instruction, modeling is done by the teacher and students observe (I do, you watch). This is followed by shared practice (I do, you help) and guided practice (you do, peers help), and finally independent practice (you do, I help if necessary).

See the Strategy Implementation Continuum for a detailed chart of this framework.
Consolidation (Elaborate, Evaluate, Extend)

Gallery Walk
Gallery Walk is a strategy to engage students in structured, low-risk discussion. Students move around the room to discuss issues in small groups. This discussion provides teachers with an opportunity to assess students’ conceptual understanding and misconceptions.

There are a variety of ways to structure Gallery Walks.

Examples:

- Students can “tour” posters, images, quotations, texts, or student work displays.
  - They can take informal notes, complete graphic organizers, respond to questions posed by the teacher, or compare displays.
  - They can tour all displays and return to their desks to do a quick-write of first impressions before engaging in whole class discussion.
  - They can position themselves at a display/centre of their choice, discuss the display/centre in relation to a question posed by the teacher with a small group, and do a quick-write in notebooks or journals articulating their understanding or position.

Exit Card
Exit cards prompt students to write responses that allow reflection on learning, for example, during the consolidation of a lesson. The exit card response can be used to provide assessment information.

See Student Success DI Package 2010, DI Scrapbook.
Optics Performance Culminating Task

Create a poster on an optical device.

Steps

1. **Use your project log** to identify questions you will use to do more research on your technology.
2. **Gather information** from the teacher and your own sources of information.
3. **Use a R.A.F.T.** to clarify your role, your audience, your goal, form of communication, and topic (content).
4. **Draft your poster** which includes:
   a. an image of your technology
   b. a description of your technology, including how the technology uses mirrors, lenses, filters, light
   c. an **impact statement** to explain
      i. how we have benefited from the technology
      ii. what are the costs and/or drawbacks of the technology
   d. a reflection, addressing one or more of the following questions:
      i. How has the technology affected or will affect my life?
      ii. How could this technology benefit society in a different way?
      iii. How might the structure of this technology change in the future?
5. **Participate in a conference** to make revisions and improve your draft.
6. **Complete a final version** of your poster.
7. **Share your poster** in a gallery walk.
<table>
<thead>
<tr>
<th>R.A.F.T.</th>
<th>Question Prompts</th>
<th>My Response</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Role</strong></td>
<td>I am an expert on my optical device. What is my role as an expert? What do I need to do to be confident as an expert on my topic?</td>
<td></td>
</tr>
<tr>
<td><strong>Audience</strong></td>
<td>Who is my intended audience? What does the audience already know? What do I think my audience will find interesting? What does my audience need to know?</td>
<td></td>
</tr>
<tr>
<td><strong>Form</strong></td>
<td>Poster on an optical device. How will I make my information clear and visually appealing? How will I incorporate: • an image • a description • an impact statement on the benefits • the costs and/or drawbacks of the technology • a reflection How will I produce my poster? What size should my poster be for the gallery walk?</td>
<td></td>
</tr>
<tr>
<td><strong>Topic</strong></td>
<td>What is the optical device/technology I am sharing information about? What are the most important concepts and facts? What can’t be answered? What information have I collected in the project log? What questions will I need to research?</td>
<td></td>
</tr>
</tbody>
</table>
# Optics Performance Task Rubric

**Note:** Lesson 9 suggests co-constructing criteria that will be used to create a rubric - this rubric is provided as a sample.

<table>
<thead>
<tr>
<th>Knowledge and Understanding</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Demonstrate an understanding of the characteristics of a technology which uses light</td>
<td>Describes characteristics of a technology, including how the technology uses mirrors, lenses, and or filters, with limited understanding</td>
<td>Describes characteristics of a technology, including how the technology uses mirrors, lenses, and or filters, with some understanding</td>
<td>Describes characteristics of a technology, including how the technology uses mirrors, lenses, and or filters, with considerable understanding</td>
<td>Describes characteristics of a technology, including how the technology uses mirrors, lenses, and or filters, with a high degree of understanding</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Thinking</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Use scientific inquiry/research skills with</td>
<td>Uses scientific inquiry/research skills with limited effectiveness</td>
<td>Uses scientific inquiry/research skills with some effectiveness</td>
<td>Uses scientific inquiry/research skills with considerable effectiveness</td>
<td>Uses scientific inquiry/research skills with a high degree of effectiveness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Communication</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Communicate information and ideas about a technology</td>
<td>Uses a poster, including image and information, to communicate with a specific audience for a particular purpose with limited effectiveness</td>
<td>Uses a poster, including image and information, to communicate with a specific audience for a particular purpose with some effectiveness</td>
<td>Uses a poster, including image and information, to communicate with a specific audience for a particular purpose with considerable effectiveness</td>
<td>Uses a poster, including image and information, to communicate with a specific audience for a particular purpose with a high degree of effectiveness</td>
</tr>
<tr>
<td>· Use appropriate science and technology vocabulary in oral and written communication</td>
<td>Communicates information about a technology for a specific audience and purpose with limited effectiveness</td>
<td>Communicates information about a technology for a specific audience and purpose with some effectiveness</td>
<td>Communicates information about a technology for a specific audience and purpose with considerable effectiveness</td>
<td>Communicates information about a technology for a specific audience and purpose with a high degree of effectiveness</td>
</tr>
<tr>
<td></td>
<td>Uses appropriate science and technology vocabulary with limited accuracy and frequency</td>
<td>Uses appropriate science and technology vocabulary with some accuracy and frequency</td>
<td>Uses appropriate science and technology vocabulary with considerable accuracy and frequency</td>
<td>Uses appropriate science and technology vocabulary with a high degree of accuracy and frequency</td>
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<tr>
<th>Application</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>· Examines the impact of the technology</td>
<td>Explains the benefits and costs of the technology with limited effectiveness. Evaluate the impact, either personal or social, of the technology with limited insight</td>
<td>Explains the benefits and costs of the technology with some effectiveness. Evaluates the impact, either personal or social, of the technology with some insight</td>
<td>Explains the benefits and costs of the technology with considerable effectiveness. Evaluates the impact, either personal or social, of the technology with considerable insight</td>
<td>Explains the benefits and costs of the technology with a high degree of effectiveness. Evaluates the impact, either personal or social, of the technology with a high degree of insight</td>
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