Teacher Package

Science and Technology Exemplar Task
Grade 2

Teacher Package

Title: Making a Toy

Time Requirements: 245 minutes (over several class periods)

Introductory activities
- Pre-task 1: 15 minutes
- Pre-task 2: 15 minutes
- Pre-task 3: 30 minutes
- Pre-task 4: 20 minutes
- Pre-task 5: 30 minutes

Exemplar task
- Part 1: 40 minutes
- Part 2: 80 minutes
- Part 3: 15 minutes

The student work is to be completed in its entirety at school.

Description of the Task

Students will build a toy for a young child incorporating mechanisms (systems of moving parts) made up of one or more simple machines (e.g., a wheel and axle, an inclined plane, a lever).

Students will complete the worksheets provided in this package and submit selected worksheets for assessment. They will also be asked to respond orally to questions posed by the teacher, and these interviews will be videotaped. The videotapes will also be used for assessment purposes.

Scenario and Instructions for Students

Students should be presented with the following scenario and set of instructions. *Teachers should explain the task using vocabulary and details appropriate for Grade 2 students:*

> *Your class has been invited to help design a new line of toys for young children. Young children need to develop "fine-motor skills", which allow them to play with small objects. The toys you design must have parts that these children can move and must include more than one simple machine.*

> *You will be sharing your design plan, a model of the toy, and an explanation of how the simple machines in the toy will help young children develop fine-motor skills. Your presentation will be part of an exhibit of toy designs that representatives of several big toy manufacturers will attend to find new designs that they can buy and manufacture.*
>
> *Your task is to develop a toy that:*
> - *contains a system of moving parts (a mechanism);*
> - *includes more than one simple machine (e.g., a wheel and axle, a lever, an inclined plane);*
> - *is no taller, wider, or longer than a letter-sized piece of paper.*
>
> *You must explain how your model toy works, including how its parts move, which simple machines were used, and how the simple machines will help children develop fine-motor skills.*

Curriculum Expectations Addressed in the Task

Note that the codes that follow the expectations relate to the Ministry of Education's *Curriculum Unit Planner* (CD-ROM).

Students will:

1. describe the position and movement of objects, and demonstrate an understanding of how simple mechanisms enable an object to move (2s66);
2. design and make simple mechanisms, and investigate their characteristics (2s67);
3. recognize that different mechanisms and systems move in different ways, and that the different types of movement determine the design and the method of production of these mechanisms and systems (2s68);
4. ask questions about and identify needs or problems related to structures and mechanisms, and explore possible answers and solutions (2s74);
5. plan investigations to answer some of these questions or solve some of these problems, and describe the steps involved (2s75);
6. communicate the procedures and results of investigations and explorations for specific purposes, using drawings, demonstrations, and oral and written descriptions (e.g., draw a sketch of an object they plan to make and another sketch of the object after it is made; tell the class the procedures they followed in making a vehicle or a container with a hinged lid) (2s78).

"Big Ideas"

Based on the expectations being assessed, the following "big ideas" have been identified for this task:

- Mechanisms can consist of one or more simple machines and can change the direction and speed of movement of an object.
- Simple machines make movement easier.
- Simple machines make life more enjoyable.

Teacher Instructions

Prior Knowledge and Skills Required

Before attempting the task, students should have had experience with the following:

- attaching axles and wheels (see Pre-task 5)
- making hinges and other simple linkages (e.g., with split-pin fasteners – see Pre-tasks 3 and 4)
- recognizing different simple machines
- using a design-process model (e.g., define the problem, brainstorm solutions, plan, make, modify, reflect – see Pre-task 2), including writing up a step-by-step procedure
- connecting parts to create movement in different ways and directions

The Rubric

The rubric* provided with this exemplar task is to be used to assess students' work. The rubric is based on the achievement levels outlined on page 13 of T*he Ontario Curriculum, Grades 1-8: Science and Technology, 1998*.

Introduce the task-specific rubric to students at least one day before administering the task. Copy the rubric for students or create a transparency to use with the class. You may find it useful to rephrase the rubric for students to help them in their work.

Review the elements of the rubric with students to ensure that they understand the criteria and the descriptions for achievement at each level. Allow ample class time for a thorough reading and discussion of the assessment criteria outlined in the rubric.

Accommodations

Accommodations that are normally provided in the regular classroom for students with special needs should be provided in the administration of the exemplar task.

Classroom Set-up

Set up the classroom as you normally would for a science and technology task, allowing enough space for students to build their models.

Materials Needed

– various commonly found materials (from home or school), such as toilet-paper rolls, cereal boxes, cardboard, film or pill canisters, popsicle sticks, paper plates, different sizes of plastic containers, plastic straws, string
– teacher-provided materials, such as scissors, paper punch, glue, low-temperature glue guns, card wheels, wooden dowels, pipe cleaners, straws, paper fasteners, tape, elastics

Safety Considerations

Remind students to work and build safely, especially if they plan to use a low-temperature glue gun. Students need to exercise caution, work in small groups of four to six, and *have an adult supervisor* whenever they use cutting, drilling, or gluing tools. Specific safety rules or reminders should be posted and taught, including the following:

- Keep tools below waist level.
- Wear goggles.
- Work slowly.
- Stay on task.

Task Instructions

Introductory Activities

The pre-tasks are designed to review and reinforce the skills and concepts that students will be using in the exemplar task.

The purpose of Pre-task 1 is to introduce the exemplar task, review the elements of the rubric, and allow time for students to ask questions for clarification. The purpose of Pre-task 2 is to review the design process with students. The purpose of Pre-tasks 3, 4, and 5 is to ensure that students have experience with various types of mechanisms and basic simple machines. If students already have this knowledge and these skills, they do not need to complete these pre-tasks in their entirety (so that less time will be required for this set of tasks); in such a case, the activities should be used to remind students of things they already know and are able to do related to mechanisms and simple machines.

Pre-task 1: Introduction of the Scenario and Instructions for Students

1. Present the scenario to the class, explaining what fine-motor skills are. Then discuss the scenario, making sure the students understand what it is about.
2. Have students recall different types of mechanisms (systems of moving parts) in their environment that might be useful for the scenario (e.g., a hinged door, a spinning wheel, a cart with a levered handle, something that rolls or rocks).
3. Review different types of simple machines, such as a wheel and axle (including pulley and gear), an inclined plane (including screw and wedge), and a lever. You may wish to post examples of simple machines for student reference.

**The rubric is reproduced on pages 60–61 of this document.*

4. Review definitions of *machine* – an instrument designed to direct or change the application of force or motion – and *mechanism* – a system of moving parts that includes one or more simple machines.
5. Brainstorm with students the various types of toys that could be used to improve young children's fine-motor skills.

Note: Consider bringing in or having students bring in for discussion purposes various "baby toys" that are designed to develop fine-motor skills.

Pre-task 2: Reviewing the Design Process

Review a design process, highlighting the following areas in particular:

- identify the problem;
- brainstorm possible solutions;
- create design sketches;
- develop a working plan;
- list materials;
- plan step-by-step procedures;
- make modifications to improve the design or model;
- reflect.

Remind students that whenever they make modifications to their models, they also need to revise their plans (e.g., by making the changes on the original designs using coloured pencil crayons and then underlining the changes).

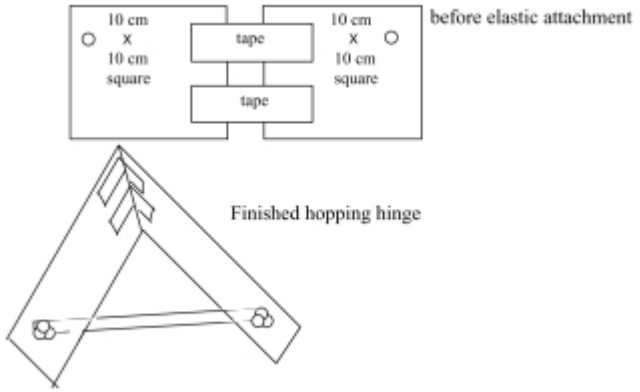
Note: You may wish to post the design process (define the problem, brainstorm solutions, make sketches, develop a plan, list materials, outline steps, modify, reflect) in your classroom for student reference.

Pre-task 3: Making Hopping Hinges

This pre-task helps students review how to assemble a simple hinge (a mechanism that is a type of lever) and add an additional mechanism that enables it to move faster and change direction.

1. Give each student two pieces of corrugated cardboard or heavy Bristol board, each 10 cm x 10 cm square, one medium-sized elastic band, and two pieces of masking tape.
   Note: The corrugated cardboard is easier to use. If the Bristol board is too light, it will buckle.
2. Have students connect (hinge) the two squares by placing them side by side on the desk with a small space (approximately 4 mm) in between. (Students may need several tries to determine the best distance.) Ask them to tape the two squares together (see the accompanying diagram).

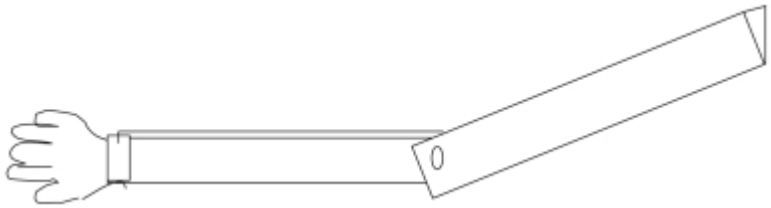
3. Have students puncture a small hole (using a pencil) towards the middle of the outer edge of each square opposite the tape hinge (see the diagram).
4. Ask students to cut their elastics and knot one end. (Teachers may find it saves time if the elastics are pre-cut with one end already knotted for students.) Have students thread the elastic through the hole of one square, with the knot to the outside, and continue to thread it through the hole in the other square, knotting the other end after it goes through the hole.
5. Have students test their hopping hinges by folding the squares, stretching the elastic until the two knots touch, then releasing, the squares. The hinge should rapidly "hop" upwards with the force of the energy from releasing the stretched elastic band.
6. If the hinge did not "hop", students make changes, including changes to the distance between the two squares or the places where the elastic is attached. (Sometimes a drop of low-temperature glue applied to the elastic knot is needed to hold the elastic in place.)



Pre-task 4: Making Levered Arms

This pre-task helps students review how to assemble a simple lever.

1. Give each student two pieces of 21.5 cm x 28 cm (8 $^{1}/_{2}$ in. x 11 in.) construction paper, another piece of coloured construction paper large enough for the student to trace his or her hand on it, a paper fastener, and a piece of tape.
2. Have each student fold each of the two pieces of construction paper in half, lengthwise, twice. Students punch a hole into one end of each folded piece (see the accompanying diagram) and attach the paper fastener through the two holes to create the levered arm.



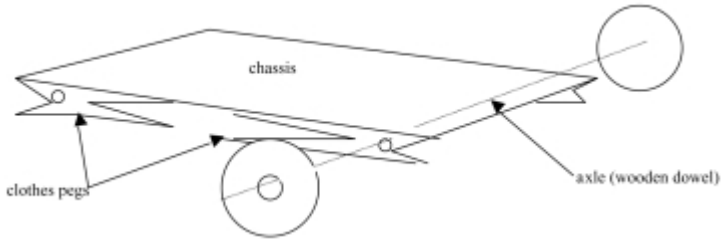
3. Ask students to attach their hands to the end of their "arms".
4. Have students test bending their levered arms.

Pre-task 5: Making Wheels and Axles

This pre-task helps students investigate various ways to create wheels and axles.

1. Using 1 cm x 1 cm wooden frames (or a piece of cardboard or coroplast, or a boxboard box) as a base, demonstrate various ways to attach wheels and axles, as suggested below:
   a) Drill four small holes in a wooden frame (i.e., where wheels would go) and screw in "screw eyes" (small screws with circular openings) to hold two wooden dowels or skewers (whose sharp ends you have sawed or cut off) parallel to the ends of the frame to form axles. Glue cardboard or wooden wheels of any reasonable size to the wooden dowel or skewer axles, which must fit inside the "screw eyes".

   b) Glue four clothes pegs (with their openings enlarged by small pieces of folded paper, if necessary) on the wooden frame, cardboard, coroplast, or boxboard to hold dowel axles (see accompanying diagram).



   c) Glue four cardboard triangles (approximately 2–3 cm high), with holes drilled in the middle of them, to the inside edge of the wooden frame, or the outer edge of the cardboard, coroplast, or boxboard box, to hold the dowel axles.
   d) Drill holes in the sides of a wooden frame to hold the dowel axles.
   e) Cut paper or plastic straws into four pieces. Glue two pieces at each end of the wooden frame, cardboard, coroplast, or boxboard box to hold the dowel axles.
2. Have students then practise some of the techniques demonstrated with their own materials (e.g., a shoebox brought from home), either individually or in small groups.

Exemplar Task

The student worksheets "What I Need To Do", "My Design Sketches", "My Working Plan", "My List of Materials", "My Step-By-Step Procedures", and "My Reflections" (see Appendices 1 to 6) are to be submitted for marking.

Part 1: Planning

1. Reread the scenario to the class and show students the materials that are available for them to use.
2. Have students complete the "What I Need To Do" worksheet (see Appendix 1). They will be clarifying the "problem" to solve or the design challenge when they complete "My job is to" and the components of the task (plan, make a model, give a presentation/explanation) when they complete "I need to").
3. Have students brainstorm as a class or in small groups possible "solutions" to the design challenge as identified in the scenario (i.e., design and build a toy).

4. Ask each student to use these brainstormed ideas, or others they think of themselves, and then choose three possible "solutions".
5. Have each student draw three design sketches on the worksheet "My Design Sketches" (see Appendix 2) representing what the student might create to meet the design challenge.
6. Have each student choose one of his or her sketches to use to design and build the finished model and then create a labelled, detailed plan of the design using the worksheet "My Working Plan" (see Appendix 3). Ask students to consider what kind of movement their toys will have, including for changes in direction and speed (e.g., pushing, pulling, squeezing, turning), and to state why they chose their particular design.

Part 2: Designing and Building

1. Ask students to list the materials needed to complete their models on the worksheet "My List of Materials" (see Appendix 4).
2. Have student use the design process, referred to in Pre-task 2, to write a step-by-step procedure of how they will design and build their models, using the worksheet "My Step-By-Step Procedures" (see Appendix 5).
3. Now have students build the models they have designed.
4. When their models are completed, have students test their models to see if they move as intended and then make any necessary changes to the models. Ask them to make changes to their plans as well (as drawn on the "My Working Plan" worksheet), using coloured pencil crayons, to represent the changes made to their models.

Note: When the exemplar task is complete, as a class or in small groups, walk students through the process of underlining all of their coloured pencil crayon changes before submitting the work for marking. Underlining is needed because pencil crayon marks will not show up in the published version.

Part 3: Reflecting and Communicating (to be videotaped)

Have students reflect on their learning by responding to the questions in "My Reflections" (see Appendix 6).

Note: The questions in Appendix 6 were used to prompt student responses in the videotaped interviews. Students were also asked to record their reflections in words or pictures on the Appendix 6 worksheets.

Appendix 1

What I Need To Do

My job is to:

I need to:

Appendix 2

My Design Sketches

Design Sketch 1

Design Sketch 2

Design Sketch 3

Appendix 3

My Working Plan

Label Your Work

Appendix 4

My List of Materials

Appendix 5

My Step-By-Step Procedures

(Remember to number your steps)

Appendix 6: Videotaping Questions

My Reflections

1. What simple machines did you use, and how did you connect any moving parts?

2. What changes did you make to improve your toy?

3. How did you use simple machines to make something move faster and/or change direction?

4. How can your toy be used to help a young child to improve his or her fine-motor skills?

5. Identify and describe an object in the outside world that uses one of the same simple machines you used in your model to create movement.

6. What are other ways we use simple machines to make our lives more enjoyable?