Building a Bird Feeder Station

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Many students have developed the opinion that mathematics is not very useful. It is not surprising in a way, as mathematics is rarely taught with a specific purpose in mind. When pushed by our students, many of us find ourselves giving trite answers to questions such as, "When am I ever going to use this?" Yet, mathematics is useful. All of that which surrounds us is rooted in mathematics, and much of our world would be different if someone had not started looking for patterns, postulating theorems and generalizing principles to new situations. The "useful" nature of mathematics is reflected in the *Junior High Mathematics Curriculum Guide*: "An application is the process of using a mathematical skill to arrive at a solution to a real life or practical situation. This aspect of mathematics is extremely important for all students to experience" (Alberta Education 1978, 7). As can be seen, the concept of applications has existed for many years. Mathematics teachers simply need to learn how to identify and adapt applications to their own teaching situations, and need to start collecting a variety of possible projects which are useful for teaching specific mathematical concepts. This paper presents the building of a bird feeder station as one possible application which would enhance the teaching of much of the junior high mathematics curriculum.

Defining and Evaluating Applications

The definition above states that applications must somehow relate specific mathematical principles and properties to the world which surrounds the students. More generally, applications should provide the intuitive sense that mathematics is real, valuable and useful.

A publication of the National Council of Teachers of Mathematics (Bushaw et al. 1980, vii) delineates three different kinds of applications:

1. Short problems similar in size and difficulty (but not in quality!) to traditional "story problems."
2. Medium-length problems that might serve as topics for a full class meeting.
3. More time-consuming problems that could be used as bases for individual study projects and the like.

The major difference in each of these types of applications is the time that is required to introduce the application, and the time required to develop and generalize from the experiences the application provides. This paper is intended to provide an example of a project application.

Bushaw et al. also list some standards by which applications may be identified and evaluated. First, the data must be realistic. If the numbers or examples within a problem do not simulate some aspect of the real world or the manner in which events unfold in the real world, then it is not an acceptable application.

Second, real data are preferable to that which the teacher creates. Wherever it is possible or reasonable for students to do so, they should be asked to research and collect data themselves. The process of collecting data allows students to fully realize that mathematics is an inherent element of our world, and it also allows the students to invest a part of themselves in the project. The greater the degree of personal investment, the greater the benefit in terms of student motivation, cooperation and interest.

Third, the application must have a sense of relevance. If the students cannot fathom why anyone would want to engage in a particular project, then that project is not appropriate for those students.

Fourth, some mathematical approach must be necessary. It is not an acceptable application if the students are not challenged by the project. Furthermore, it is not an acceptable application if the students need not apply any of their mathematics skills or knowledge to resolve any of the problems inherent within the project.

Fifth, the project must not rely upon the repetitive use of a memorized algorithm. To use the context of the application to introduce, develop and present mathematical concepts and principles is acceptable and desirable, but to simply ask the students to use a formula not previously discussed or to use an equation which was developed elsewhere is not acceptable. The purpose of applications is to bring to the surface the meaningful nature of mathematics, not simply to provide another source or form of drill and practice exercises.

Building the Bird Feeder Station

To assemble the feeder, follow these instructions:

1. Cut the bottom piece and seed retainer pieces (see ① in Diagram 1). Attach these pieces to the bottom of the feeder station using small nails (see Diagram 2).

2. Cut the back piece and attach to the bottom piece (see ② in Diagram 1) with two screws which pass through the back piece into the bottom piece.

3. Cut the internal tin slider and bend it into the correct shape (see ③ in Diagram 1). Attach this slider to the back and bottom using four small nails (see Diagram 3).

4. Cut the side pieces and the four glass guides to fit to the inside fronts of the side pieces (see Diagram 4). Attach both sets of sliders to the side pieces; each glass guide will require three small nails (see ④ in Diagram 1).

5. Attach the sides to the back and the bottom (see ⑤ in Diagram 1). Two screws on each side will pass through the side piece into the bottom piece. Two screws on each side of the back piece will pass through the back piece and into the side pieces.

6. Cut the glass front and insert between the glass guides. The glass front is held in place by the glass guides and is held up from the bottom piece by resting on the seed retainer pieces.

7. Cut the top piece and lid to fit. The top piece should be large enough to leave a 2 cm eave around each side of the bird feeder. Attach the top piece with four screws (see ⑥ in Diagram 1).

8. Paint the exterior and lid of the bird feeder station.

9. Once the paint is dry, attach the lid to the top of the bird feeder station using a single screw (see ⑦ in Diagram 1).

10. Fill the bird feeder station with birdseed and attach it outside the classroom window, or attach it to a backyard fence or pole.

Note: Not all dimensions of each individual piece are given. Many of the specifications are deliberately minimized to promote active discussion and problem solving. Students will need to visualize precisely how certain pieces will fit together (for example, the back piece to the top piece) to make decisions regarding exact dimensions.

Correspondence to the Mathematics Curriculum

A project as large as this relates to many different components of the junior high curriculum. A few are identified below.

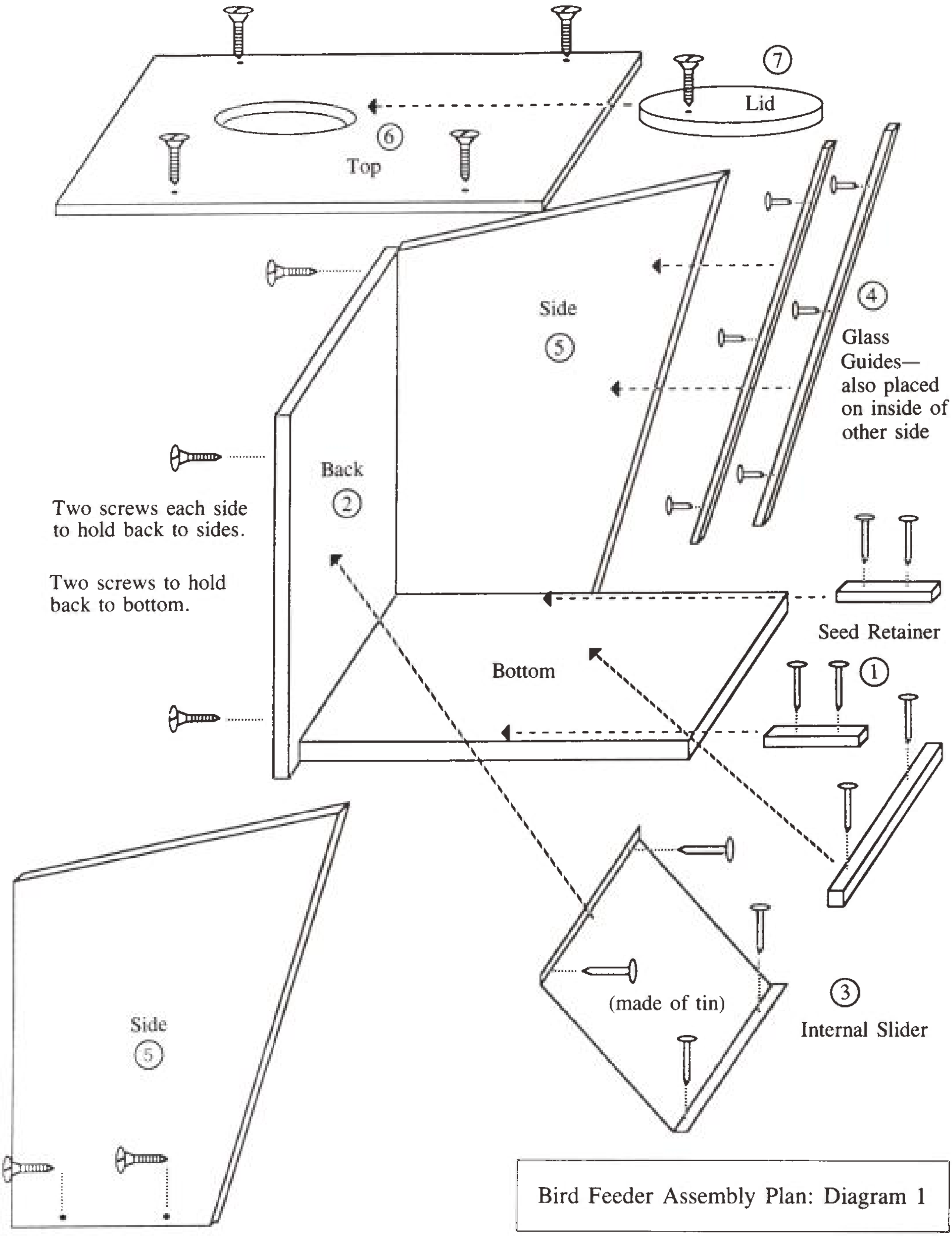
1. Pythagorean theorem. There are several points at which the Pythagorean theorem may be implemented in the completion of this project. In the construction of the side pieces, two right angled triangles are removed from a rectangular piece of wood (see Diagram 4). The lengths of the hypotenuses of these triangles relates to the length of the top of the feeder station and to the length of the glass front and glass guides. For example, once the triangle that measures 16 cm along one side and 4 cm along a second side is removed, the length of the hypotenuse is needed to calculate the dimensions for the top piece as shown below:

Length of Top = Lengths of Eaves + Length of Hypotenuse

$= (2\text{ cm} + 2\text{ cm}) + \sqrt{(16\text{ cm})^2 + (4\text{ cm})^2}$

$= 4\text{ cm} + 16.5\text{ cm}$

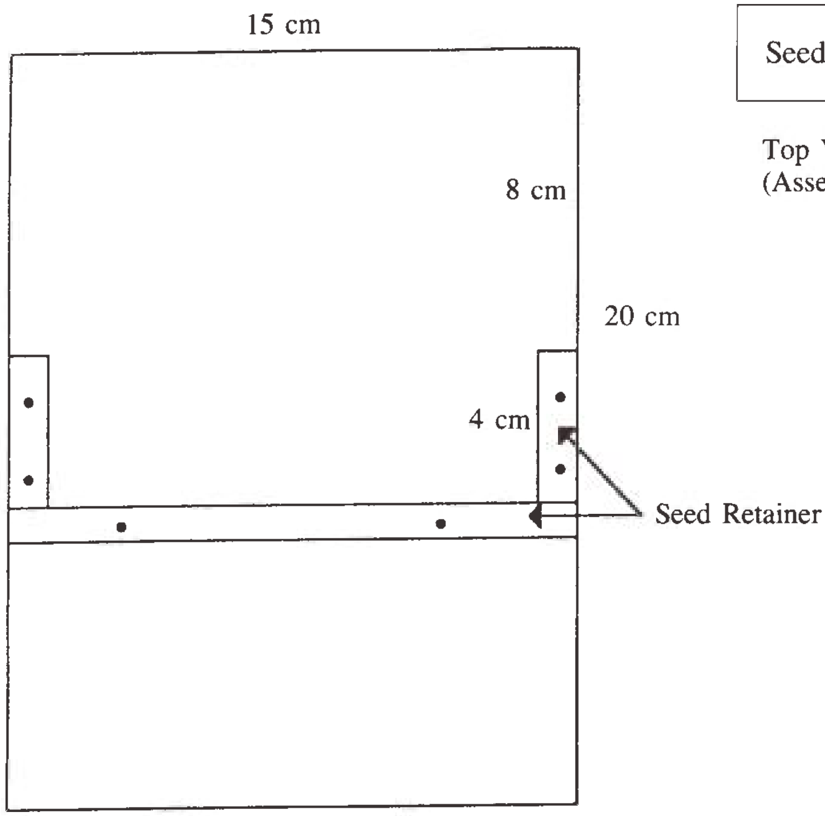
$= 20.5\text{ cm}$



Bird Feeder Assembly Plan: Diagram 1

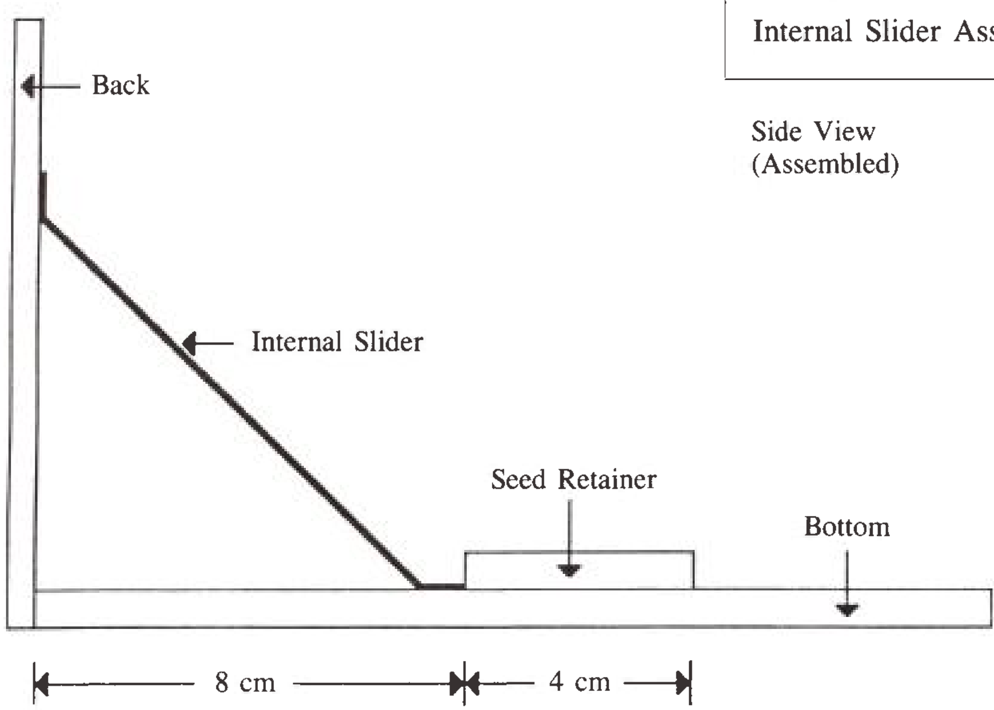
Seed Retainer Assembly: Diagram 2

Top View
(Assembled)

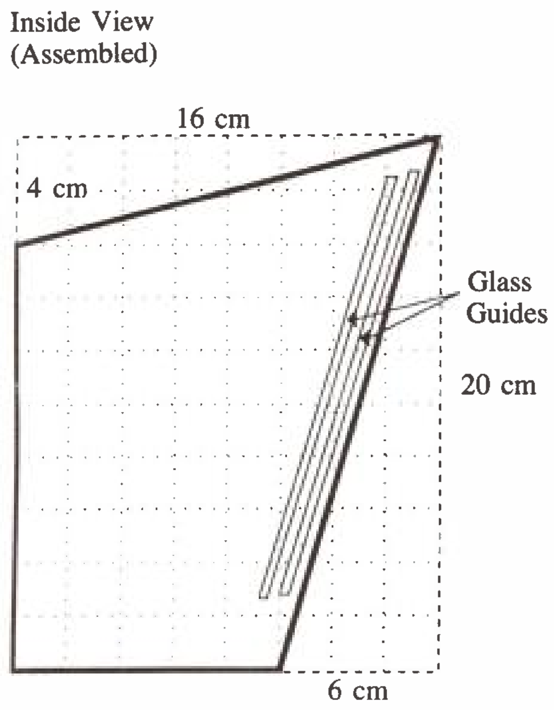


Internal Slider Assembly: Diagram 3

Side View
(Assembled)



Side Piece Assembly: Diagram 4



The Pythagorean theorem could also be employed to calculate the length of the internal tin slider. This problem is a little more complicated as the exact length is variable, although the tin piece must be at least 11 cm in length.

2. Problem Solving. To calculate the dimensions of certain pieces prior to cutting them from the wood, many multistep problems must be completed. These problems often require (and allow students to practise) much higher order thinking skills such as visualizing, generalizing, estimating, rounding and evaluating. As the teacher works through these problems with the students, the teacher has the opportunity to point out the different approaches which students adopt and thus identify the variety of strategies which are available in problem solving. Some students will want to try guessing and checking, others will try to list needed information, others will look for simpler or alternate questions. All of these approaches could lead to correct answers in the variety of specific tasks which are a part of this project. The problem solving nature of this project is a direct function of the amount of information which is given, thus teachers should be careful not to give away too many answers. A better teaching strategy would be to encourage students to ask alternate questions of themselves and their peers. In general, as the problems associated with this project are solved, the students will have the opportunity to demonstrate interest in problem solving and experiment with a variety of heuristics, and the teacher will have an opportunity to discuss the stages and strategies of problem solving.

3. Surface area. The surface area must be calculated in deciding how much wood and other materials need to be purchased for one station or for the entire class set. External surface area will also be needed to calculate the amount of paint needed to finish the project.

4. Volume. The volume of the feeder is important when filling the stations with birdseed. This problem is certainly not trivial, as several triangular prisms must be subtracted from the basic rectangular shape of the interior. The teacher will also have the opportunity to discuss the need for appropriate units as these calculations are completed.

5. Geometry. This pattern for a bird feeder station contains many different shapes, including circles, rectangles and triangles. Each of these shapes may be discussed in terms of the vocabulary that they support. For example, the lid must be cut in such a way that it is larger than the hole it covers. This fact provides the opportunity to talk about the concepts of radius, diameter and area of circles. Also, the simple fact that one side piece is a translation of the other and that the lid rotates about the screw provides a context in which transformations may be introduced and discussed.

6. Money. Once all the bird feeders have been constructed, they could be entered into a garage sale to raise money for some school project. The process of selling the bird feeders provides the opportunity to relate surface area to cost, and provides the opportunity to discuss percentages in terms of percent profit and loss.

7. Ratio and proportion. The concept of ratio and proportion can be introduced after the volume of the bird feeder stations has been calculated. This concept is needed to determine the least number of bags of birdseed which must be purchased to fill each feeder a given number of times (you may wish to provide extra seed to the individual who purchases your bird feeder station).

8. Number systems. Concepts from this portion of the curriculum which students will encounter include whole numbers, decimals, fractions and rounding. Students will also have the opportunity to work with calculators, and the project itself may serve as a form of manipulative around which many teacher- and student-derived problems may be created.

Issues in Classroom Implementation

Many junior high mathematics concepts are inherent within the structure of this bird feeder station. Identifying which topics are inherent within each piece and thus pacing the assembly of the bird feeder station with the development of the corresponding concepts becomes the teacher's task. However, the teacher may choose to save this activity as a type of extension and build the feeder station with the students at the end of the semester, or the teacher may prefer to use this project as a form of review. In either case, the feeder station will serve the function of providing a context in which mathematical concepts may be discussed.

To make these concepts explicit, the teacher must be certain that key vocabulary terms are used and noted for the students' benefit. The learning and teaching context which surrounds a project application is that of class discussions. For discussions to occur, students need the vocabulary to communicate and share their ideas and to make their experiences meaningful. The teacher's job is to make sure that in all the activities which surround this project, the mathematical knowledge which the project embodies is brought to the students' attention. It cannot be assumed that by simply building this bird feeder station the students will learn mathematics any more than it can be assumed that because they complete a page of equations they understand the nature of algebra. In both instances, the discussions that the teacher leads and the manner in which focus is brought to the principles involved determines the amount of learning and understanding which will evolve. Teachers must be willing to make explicit the concepts and vocabulary which students are to learn, and teachers must be constantly ready to build upon the insights which students provide to lead these students forward to constantly greater levels of comprehension.

Teachers must carefully analyze their roles in activities such as this. When should the teacher interrupt the proceedings to present theorems or major concepts? When and how should the teacher assist the students in generalizing from one problem situation to another? That the role that the teacher plays in these project applications is somewhat different than the traditional role immediately becomes obvious. Teachers must learn to be more patient and to ask probing questions that allow students to realize that their present knowledge level is not sufficient for all tasks. When students realize that a knowledge gap is present and that this gap prevents them from solving a given problem, then these students will be more motivated to listen and learn to eliminate that gap (Posamentier 1986). For example, the teacher may ask the following question (or perhaps this question may be asked by one of the students): "Is there any way that we can determine the length of the top piece without measuring the top edge of a side piece?" This probing question establishes the context in which the Pythagorean theorem can be introduced. The teacher needs to be able to recognize this question as the beginning of a teachable moment to help students develop and generalize mathematical knowledge.

Teachers must realize that their responsibilities are to empower students to ask questions of themselves and of each other, to clarify their thinking and to apply their realizations toward the completion of a greater task. Project applications thus lead students to higher levels of cognitive activity while learning the prescribed curriculum. In short, the advantages that project applications provide include a motivating learning environment, a context in which principles can be discussed and applied, an opportunity to extend and enhance mathematical vocabularies, as well as means to inculcate and practise higher order cognitive skills.

Students will probably never stop asking, "But when will I use this?" And perhaps there will always be teachers who will respond, "You'll need it next year," or "You'll need it to pass Grade 8." Teachers need not be satisfied with answers such as this. Project applications provide an alternative.

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