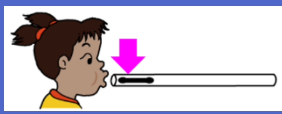
Teachers' Guide for

Hypothesis–Experiment Class

Introducing Dynamics by Blow-Dart Experiment



Edited by
Association for Studies in Hypothesis–Experiment Class (ASHEC) Translation Project Group

Preface

We appreciate your interest in Hypothesis–Experiment Class (HEC).
Introducing Dynamics by Blow-Dart Experiment was newly edited by the Association for Studies in Hypothesis–Experiment Class in response to the Japan International Cooperation Agency's request for cooperation. With the permission of the copyright holders, we have now edited and published an international version as a flip book. It can be printed and used as a flip book or projected on a projector.

Initially, this plan was a part of an unfinished HEC Classbook *Introduction to Mechanics*, which was being prepared based on the idea of the original author, Kiyonobu Itakura. ASHEC members have implemented the part as a small lesson plan for about 20 years in various school types and community science classes in Japan. It has become a popular introductory science lesson for beginners to enjoy thinking about the forces and time that move things.

This guidebook includes tips on conducting each experiment and information for preparing classes. We hope teachers conducting Hypothesis–Experiment Class for the first time can enjoy the classes with their students.
Please read the separate ' Hypothesis–Experiment Class Management Guide.' for an overview of the concept and principles of classroom management for HEC.

If you have any queries, please get in touch with us.
We would appreciate it if you could provide our Association with a record of your class (target age group, country/region, students' impressions, number of students on each 5-point scale, your impressions as a teacher, etc.). Your record is valuable and needed to improve the Classbook.

ASHEC Translation Project Group
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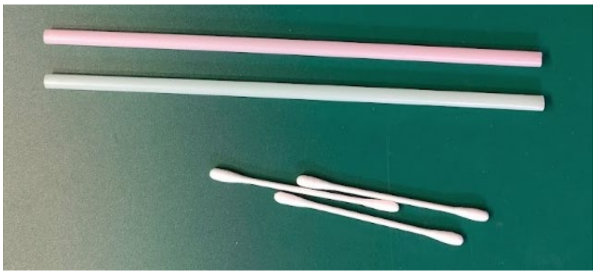
Table of Contents

Experimental equipment required

Straw



The straw in the photograph is 21 cm long and 6 mm in diameter, made of polypropylene. Other materials and sizes are also acceptable. Use whatever is available, prioritising the combination size with cotton swabs. Straws with a bendable bellows part are also available. If it is challenging to keep them straight, you can use just the straight part. Changing the straw for each Problem is better because the inside will become damp after repeating the experiment.

Cotton swab

The cotton swab in the photograph is 5 mm in diameter and 7.8 mm long. It is easier to use one slightly thinner than the inner diameter of the straw.

If the swab is too thick, it may be possible to adjust it by removing some of the cotton. The teacher should have sufficient swabs, which must be replaced with new ones for each experiment demonstration.

Markers for cotton swab landing points

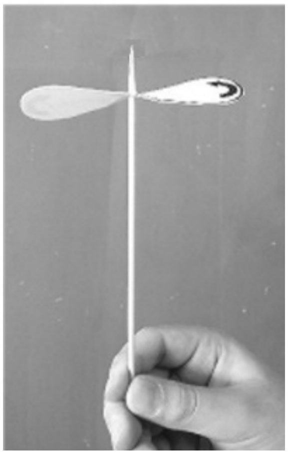
Paper cups or cards, vinyl tape, stones, rolled-up paper tubes, etc.

Use a different colour or mark for each experimental condition.

Newspaper

Use for Problem 7. If the paper is thin, you can use two layers.

Materials to make a Tombo



Thin sheets of PP or PET material, thin rods for shafts

See the instructions and pattern on the last page of this document.

Explanation and Tips for Class Management

▶indicates a standard guide to HEC, ▶ indicates an explanation for this HEC Classbook.

Preface pages

Relax! Enjoy the class together with your students.

HYPOTHESIS–EXPERIMENT CLASS (HEC)

The teacher proceeds with the lesson by showing the Problems, Readings and Hands-on on this HEC Classbook flip, one at a time, following the order of the flip:

Problem

1. The teacher reads the problem.
2. Students choose the options for their expectations.
3. Count the number of students who chose each option and show the tally to the pupils.
4. Ask students who wish to speak to give their reasonings or thoughts.
5. Discussion. The teacher should not correct the students or guide them to the correct answer. / 6.Before the experiment if a student wishes to change the choice, the teacher always records it.
7. Experiment. The teacher declares the result but does not explain it at the stage.

Problem 3

a. One straw pipe	5		7
b. Two straw pipe	28		26
c. About the same	2		2

Readings

The teacher reads the reading. In Hypothesis–Experiment Class, the explanations, and summaries necessary for the students' understanding are given as Readings at the necessary stages in the sequence of problems in the HEC Classbook.

After Class

At the end of the class, ask the students to rate their enjoyment of the class on a five-point scale and write down their impressions.

Please always refer to the attached 'Classroom Management Guide' to ensure that your classes run worry-free and enjoyable.

The next and subsequent slides can be printed in large print and used as flips for the class.

★A3 size or larger printing is recommended.

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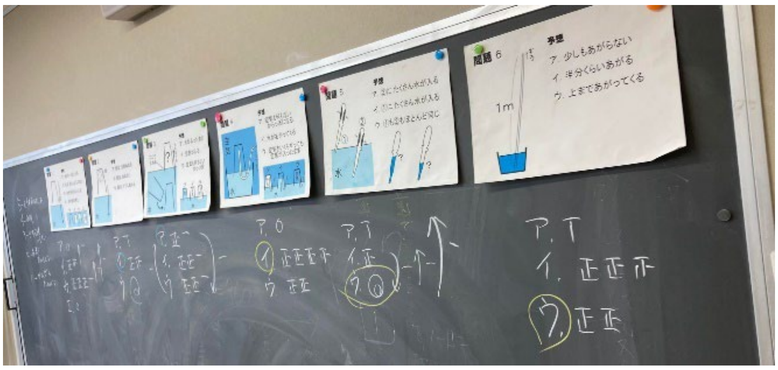
▶The following subsequent slides can, of course, also be presented on a projector.

▶How to use the flip

In addition to using a display stand to flip through the pages, you can also take out the pages with choices and stick them on the blackboard, and then write a tally table of predictions underneath, as shown in the picture.

In a Kenyan high school, a flip table is placed at a position that is easily seen by all the students. Students need to know what they are currently working on.



A Japanese primary school teacher uses flips of the prediction options, sticked on the blackboard for another Classbook lesson. '正' is the Japanese symbol for counting up to 5.

Flip cover

Introducing Dynamics by Blow-Dart Experiment

Hypothesis–Experiment Class

Original Work by

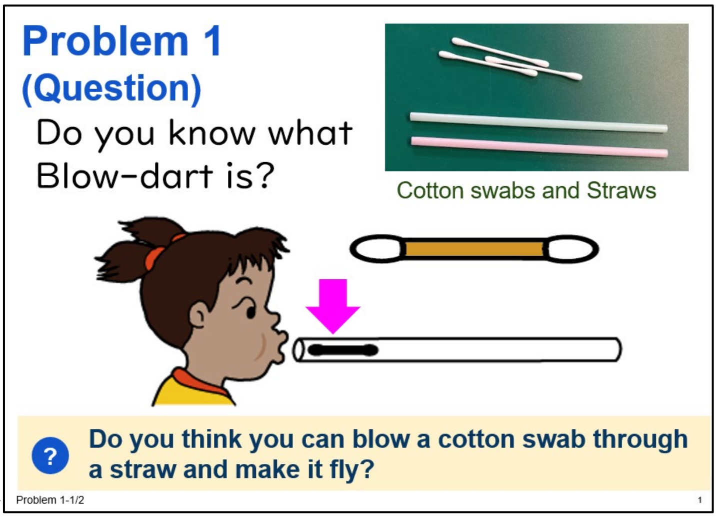
Kiyonobu Itakura

This flip was translated and edited by the Association for Studies in Hypothesis–Experiment Class from the chapter "Blow-Dart and Dynamics" in the HEC Class Book "Introduction to Mechanics", conceived by Itakura, and is published with the consent of the copyright holder.

Association for Studies in Hypothesis–Experiment Class

Problem 1-1/2

Problem1-1/2



The overall page number

► "Problem 1-1/2" is found in the bottom left-hand corner of the page. These numbers indicate that problem 1 consists of two flips; this flip is the first.

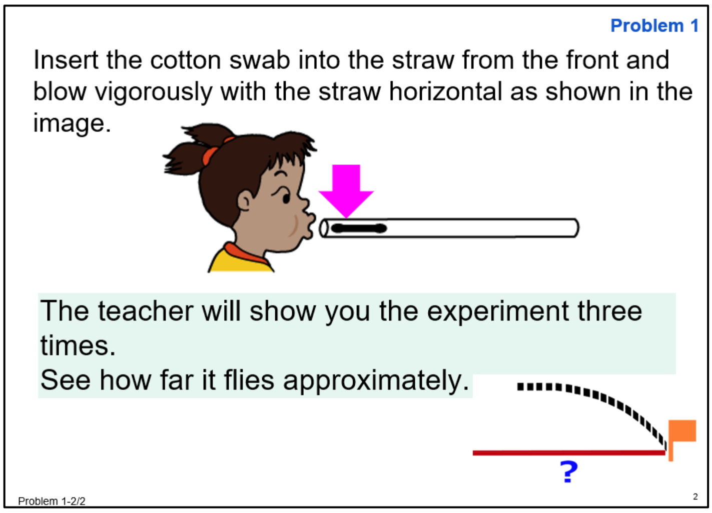
There is an overall page number at the bottom right of the screen.

►This is an introductory **Question**. The aim is to introduce the tools to be used for future **Problem**s. If any students wish to speak in response to the question, they may do so, but there is no need to encourage further discussion.

Show the actual straws and cotton swabs. The teacher should walk around among the students and show them the material. Also, show them how to insert a cotton swab into a straw.

►In the animated version, Problem 1 asks whether there would be any difference in the results if a different person blew, considering that some students may not know about the experimental material. However, in the flipped version, the authors have revised this Problem to a simpler version as a **Question**. Only the first question may be replaced by this one when using the animated version.

Problem 1-2/2



►Before each lesson, the teacher should always do a preliminary experiment. Always experiment in a place and position visible to all students.

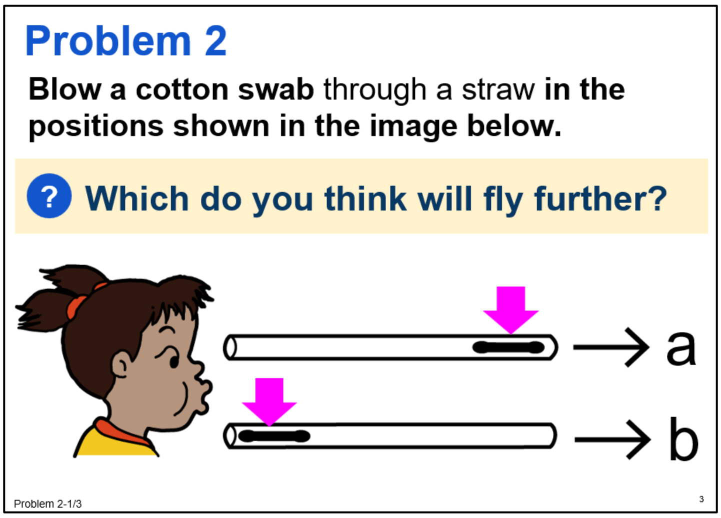
► In advance, the teacher shows the students how to experiment by imitating blowing a cotton swab through the straw, saying, "I'm going to experiment this way."

Explain that the landing point of the swab will determine how far it flew. It is a good idea to ask students to help by placing a marker (e.g., a coloured cup, paper triangular pole, etc.) at the landing point.

►Then, say, "Everyone pay attention." and show the students the experiment three times. The swab should be replaced with a new one for each trial.

►Straws should be replaced after each Problem, as the tube inside will become damp from your breath as you use it.

Problem 2-1/3

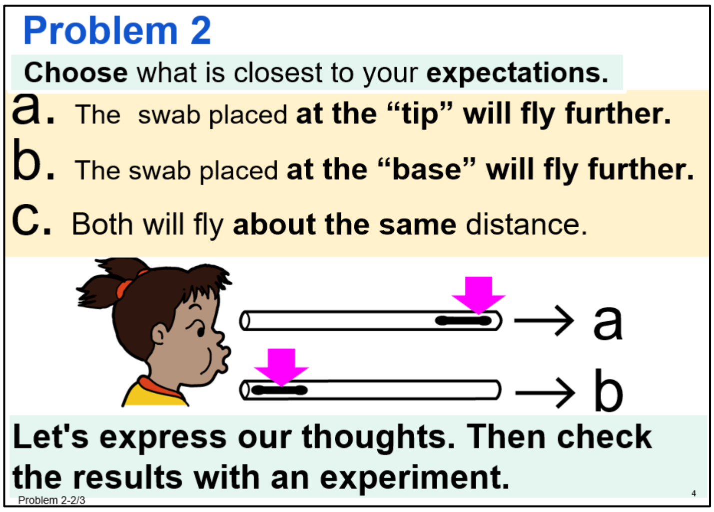


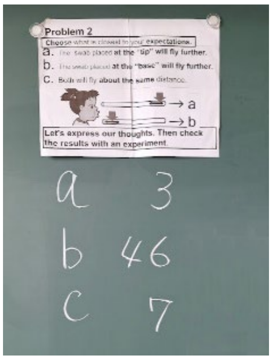
►For **Problem**s, ask each student to predict the experiment's outcome. Ask each student to raise their hand to choose the option closest to their expectation.

►Emphasise to students that the position of the swab is different from Question 1. The prediction options are on the next page.

►HEC does not require students to make logically thought-out predictions from the outset. That is why we often use the term **Expectation**s instead of predictions. As students work through a carefully sequenced sequence of problems, they gradually realise the effectiveness of making predictions based on logical thinking, even if there are differences in individual cognitive processes.

Problem 2-2/3





►The teacher reads out each prediction, asks students to raise their hands, and then tallies them on the blackboard.

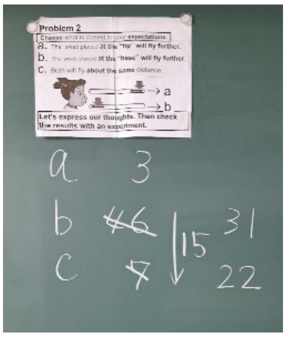
Next, the teacher asks the students to talk about their choices and predictions, asking them to raise their hands if they wish to speak. The teacher should not force students to speak.

►The teacher's role is to create an atmosphere where students who want to speak can present their ideas. Whatever the students' statements are, do not express your opinion or thoughts on them at this stage. Whatever the statement is, say, 'I see, so you thought.' or 'I see, so that's what you think. Thank you.' and accept it as it is.

► It's okay if students start discussing and exchanging ideas with each other in small groups. Teachers should advise each student to choose which option to use, although they may discuss it with friends sitting beside them.

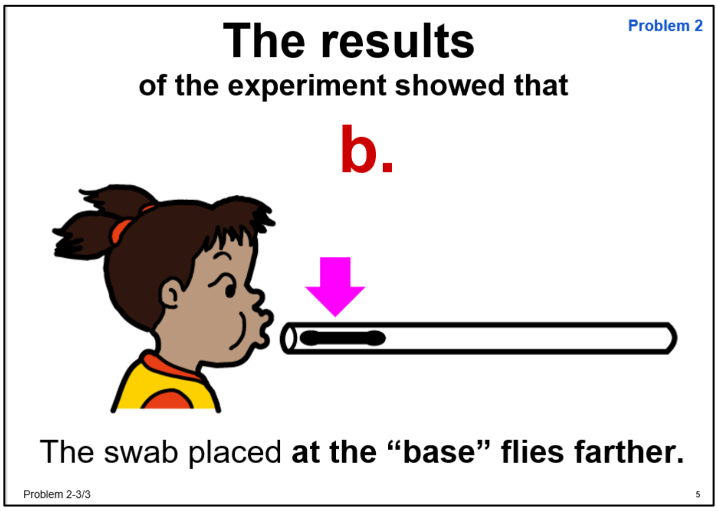
►Students should be allowed to nod or applaud to agree with a student's statement. Rather, they should be encouraged.

►The teacher may nominate someone if no one wishes to speak, but in that case, it is acceptable for the student to say 'sort of' or 'for no clear reason.'



►After the students have finished speaking (or if no one speaks up after looking at the tally), ask if anyone wishes to change their choice. If anyone wishes to change, update the table with the change. After that, proceed to the experiment.

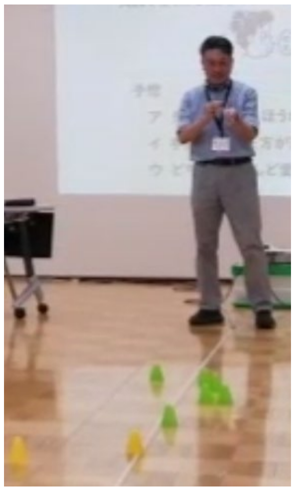
Problem 2-3/3



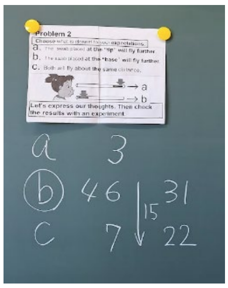
▶ Experiment in a place where it is easily visible. Demonstrate the experiment by saying, 'Come on, let's do it!' so the students can pay attention.

▶For ease of understanding the experiment's results, it is recommended that the markers placed on the landing points of the cotton swabs are of a different colour for each condition.

▶The experiment results should be compared with approximate landing points, not exact distance measurements.

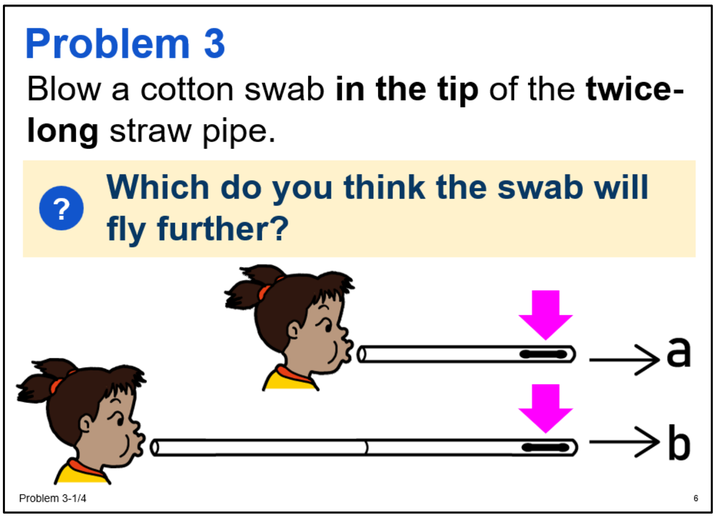


▶ When the experiment results are given, ask: 'What was the result?' (‘experiment result’ rather than 'correct answer') and mark the choice by declaring, "Yes, it was, ." or "The result showed this option."



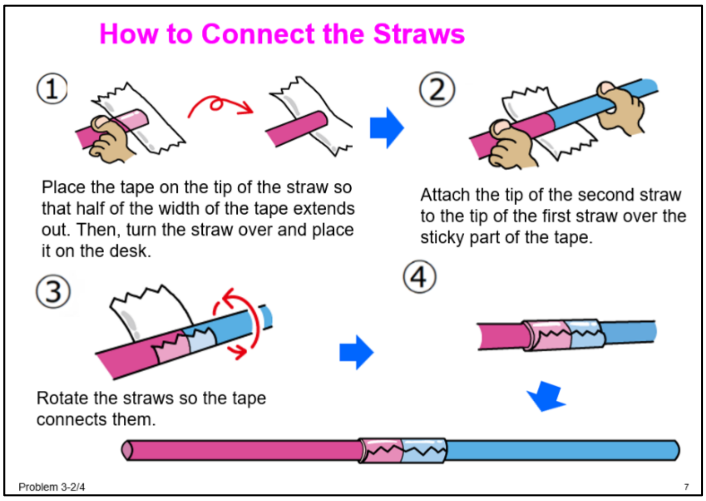
▶**The teacher should proceed to the next question without explaining the result.** The series of Problems in a Hypothesis-Experiment Classbook allows students to build scientific awareness through their own questioning and verification by experimentation. Explanations and interpretations are provided as 'Readings' at the necessary stages for the student's understanding.

Problem 3-1/4



►Read the Problem, pointing to the position of the swab with a flip.

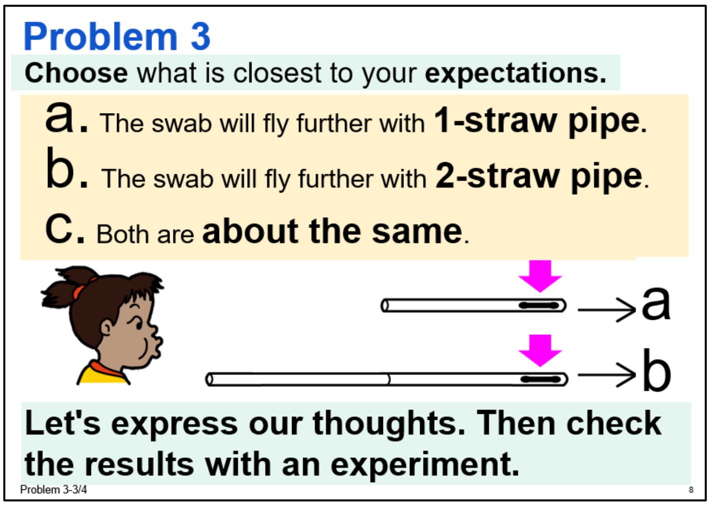
Problem 3-2/4



►This is an explanation of how straws are connected. The pupils only need to know that long tubes are made by connecting straws in this way, so the teacher should proceed to the next page of predictions after briefly showing this page.

►The teacher should have the required number of long tubes connected in this manner ready before class.

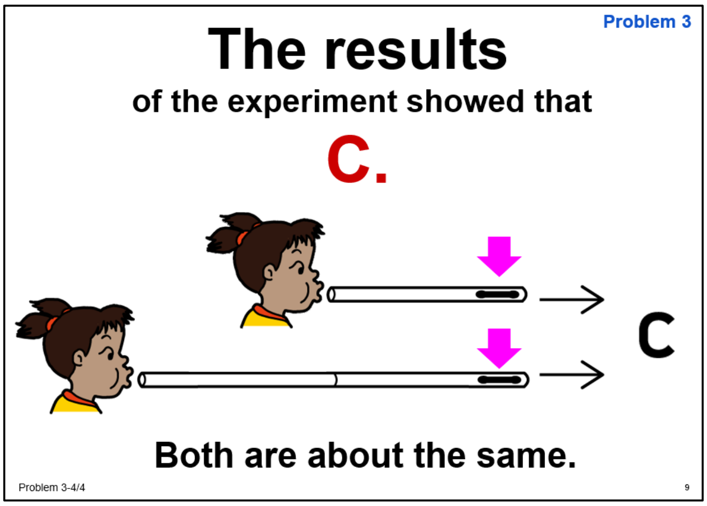
Problem 3-3/4



►Proceed in the same way as in the previous Problem.

Explain the experimental procedure, emphasising that the cotton swab is placed at the tip of a straw.

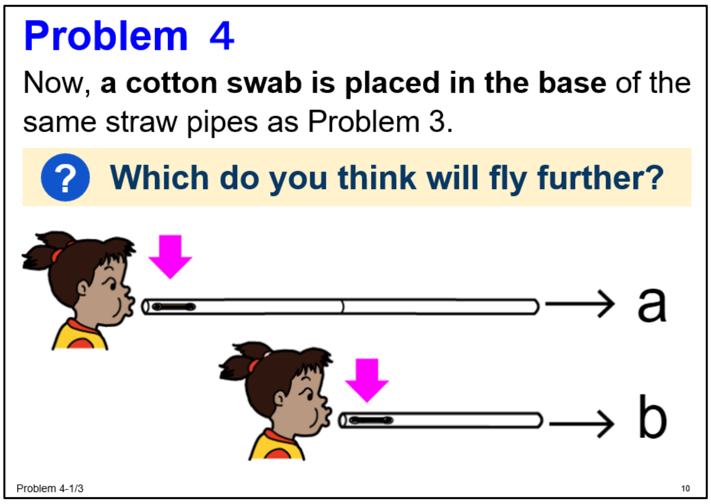
Problem 3-4/4



► 'What were the results of the experiment?' When reviewing the results with the students, it may be fun for the teacher to see them discussing the results and being pleased that their predictions were correct.

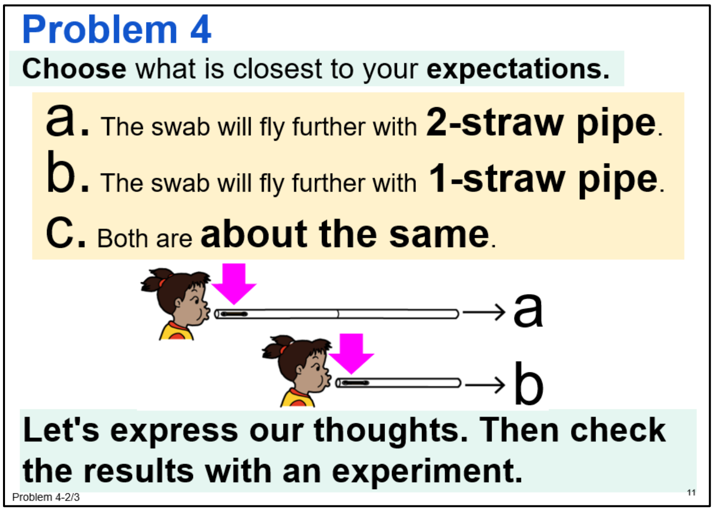
The teacher prepares for the next page and does not explain the results of this experiment but moves on.

Problem 4-1/3



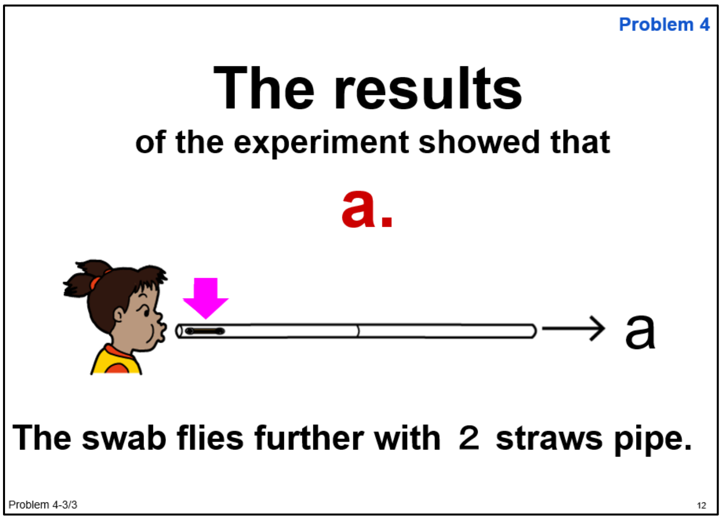
►Problem 4 uses the same pipes as in Problem 3, but the position of the swabs is different. Please highlight the difference.

Problem 4-2/3

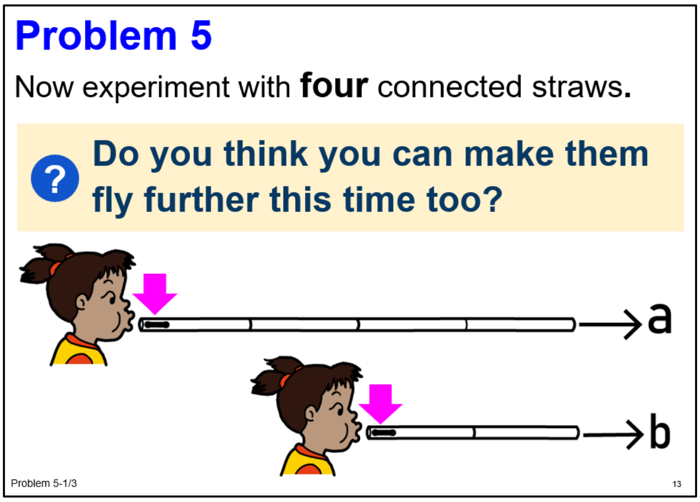


►As in the past, try to maintain a relaxed atmosphere in the class.
If you see a student discussing a topic with a friend sitting nearby, encourage them to 'It's fine to talk it over, but please think and decide for yourself when choosing which prediction to make.'

Problem 4-3/3



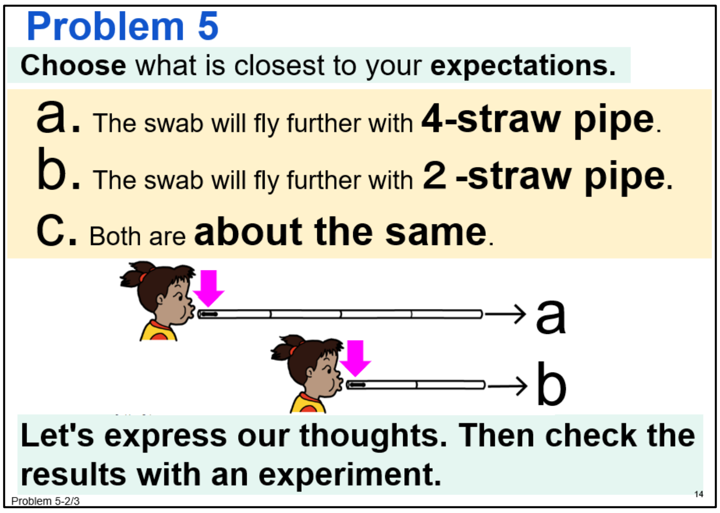
Problem 5-1/3



►Show the students a four-straw pipe and a two-straw pipe.

Once again, emphasise that the swab is set at the base. Also, explain that the teacher will experiment by holding the blowing tube so the tips are in the same position.

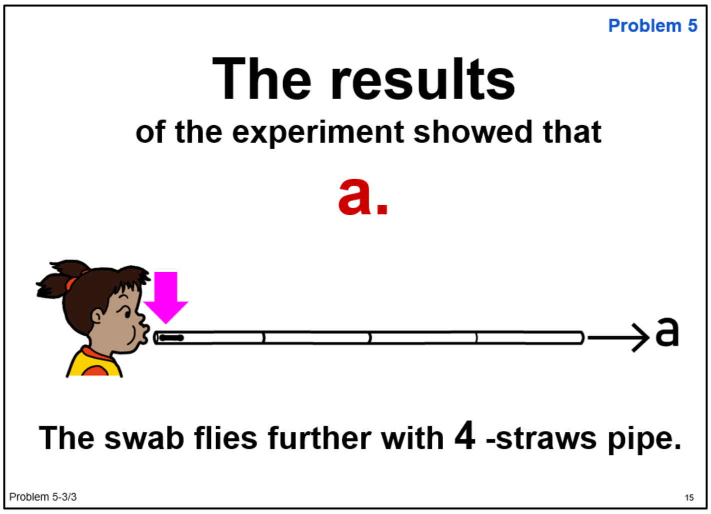
Problem 5-2/3



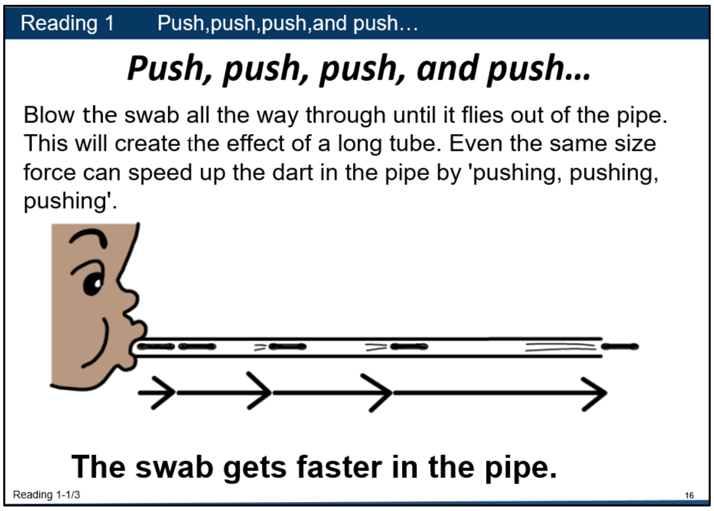
►The four-straw tube can be pretty long and easily bent, so when blowing the dart, hold the tube straight with your arms outstretched.

►In practice, the swabs can fly quite far. Do some preliminary experiments to determine the location and direction of blowing where the results are easier to see. The location and direction of the experiment need not be the same as in previous problems.

Problem 5-3/3



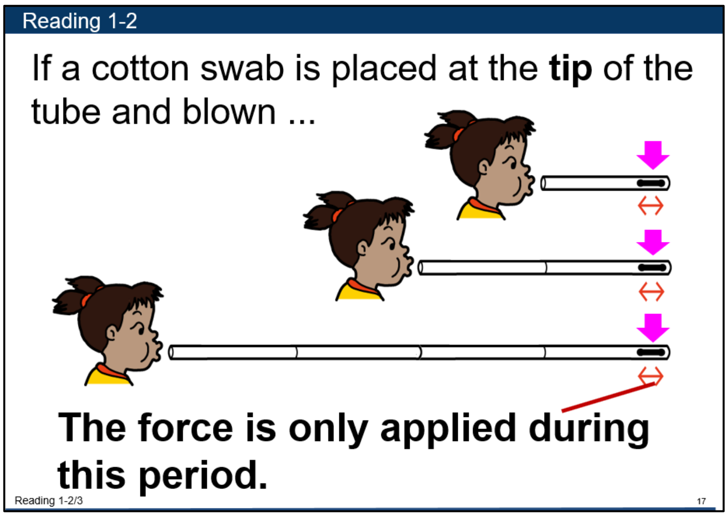
Reading 1-1/3



►The teacher says: 'This flip (slide) is not a **Problem**. It is a **Reading**. Now let's think about what the experimental results of all the Problems so far have shown us as we read this.' The teacher then begins to read the reading material.

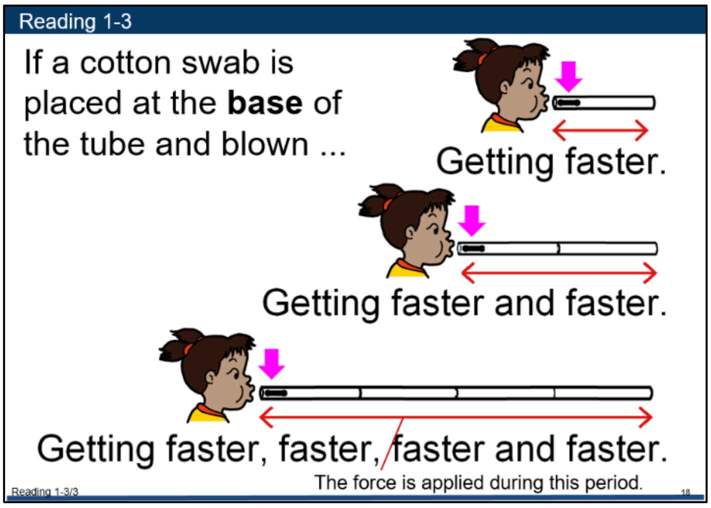
►Read rhythmically and pleasantly the 'pushing, pushing, and pushing' part, showing pictures and repeating the words. Have students focus on the length of time the swab is being pushed.

Reading 1-2/3



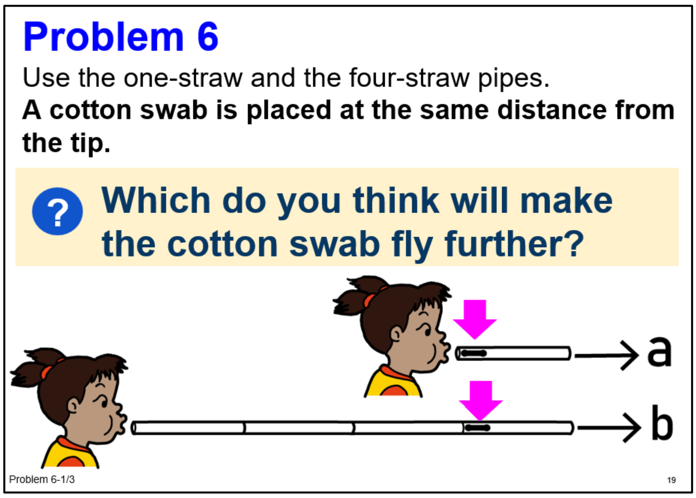
► In any experiment where a cotton swab is placed at the end of the tube and blown, the teacher should emphasise that in all cases, the 'time' the swab is being pressed is short.

Reading 1-3/3



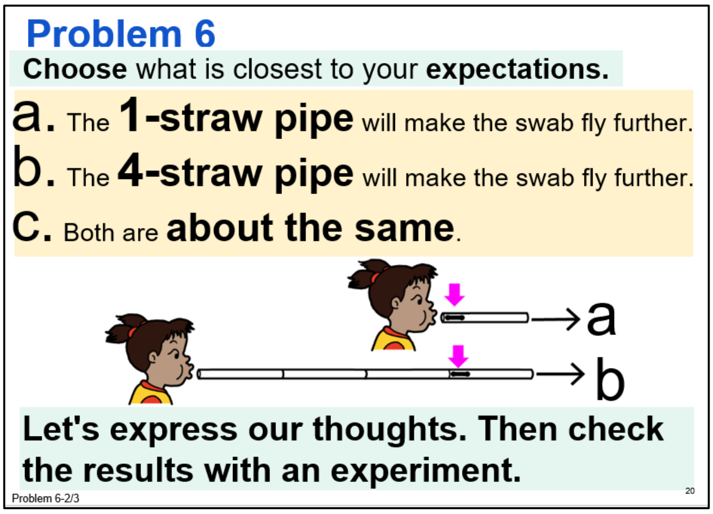
► Emphasise time, not distance. The diagram illustrates that the longer the time of the push, the faster the speed increases.

Problem 6-1/3



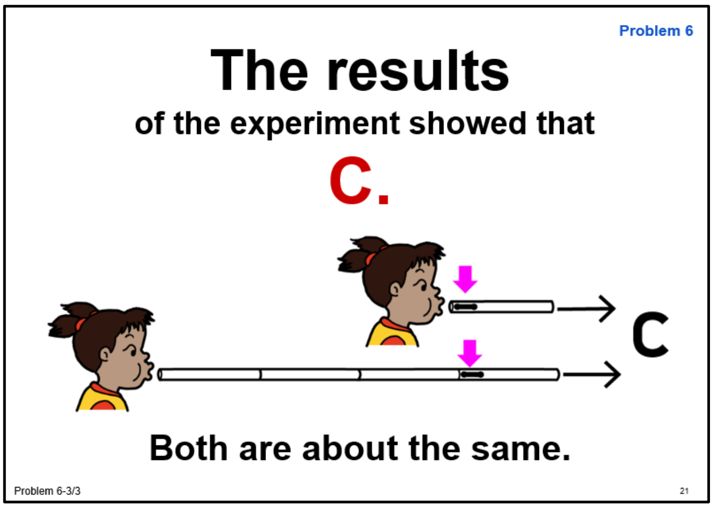
► In this Problem, the position of the cotton swab may be a little confusing. Before asking students to make predictions, use the diagram to ensure the swabs are placed at the same distance from the tip.

Problem 6-2/3

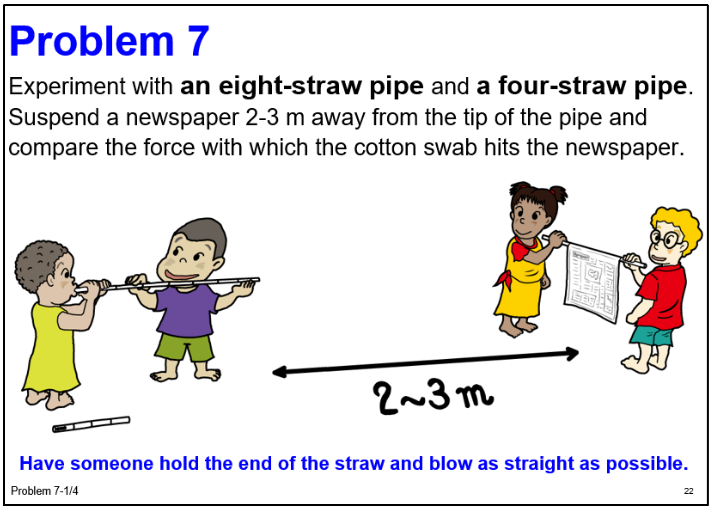


►To set a cotton swab into the tube of b, insert it from the tip and gently tap the tube while tilting it, or try pushing it into the tube with a thinner stick.

Problem 6-3/3



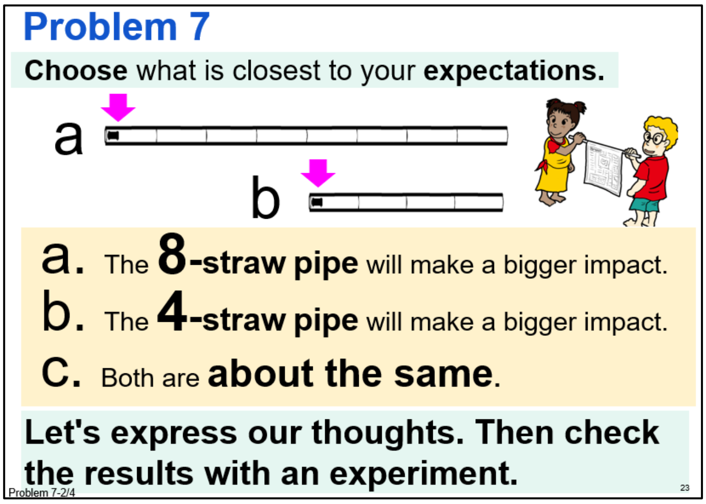
Problem 7-1/4



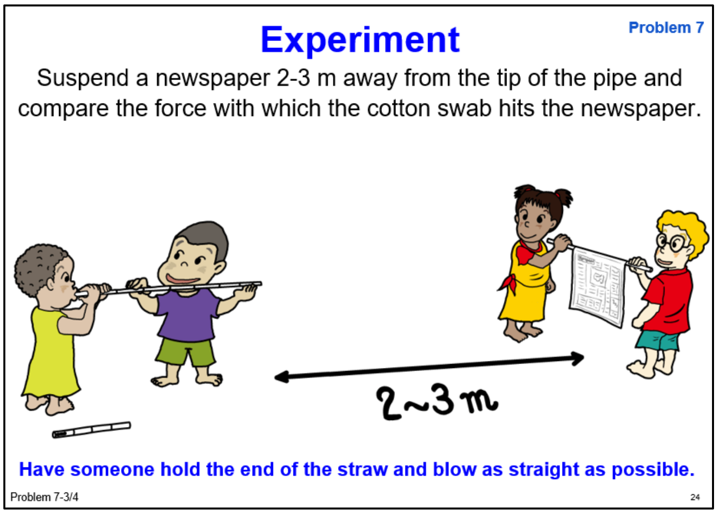
►In both cases, experiment with the same distance from the straw tip to the newspaper.

For detailed instructions on how to conduct the experiment, see the 7-3/4 Experiment page.

Problem 7-2/4



Problem 7-3/4



►The teacher may ask students to hold the newspaper and hang it up as shown in the diagram or use a tool to hang it up.

►The distance to the hanging newspaper should be such that when you blow with a four-straw pipe, the cotton swab either bounces off the newspaper, falls out, or sticks in and does not penetrate through. A preliminary experiment is needed to adjust the distance for a demonstration experiment in the classroom.

►In both cases, experiment with the same distance from the straw tip to the newspaper.

►The eight-straw pipe is very long, so have someone hold it up and keep the tube straight while blowing. Alternatively, blow it while it is on a table, as shown in the picture.

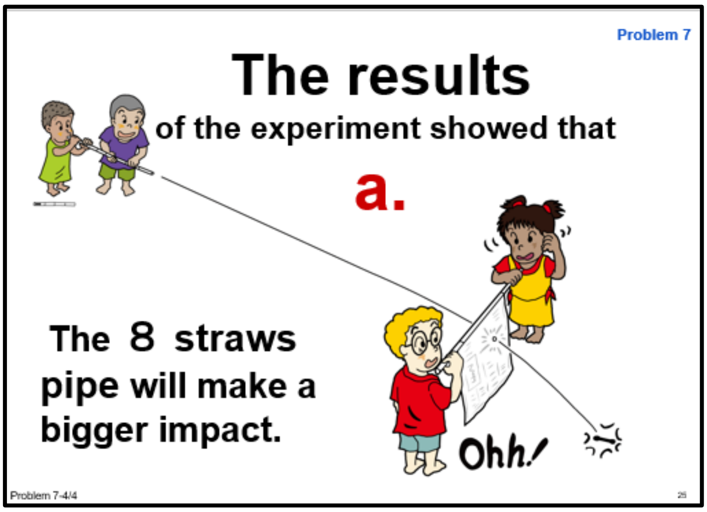
►In both cases, experiment with the same distance from the straw tip to the newspaper.

►The four-straw pipe was also used in Problem 5. However, this is the first time to blow the swabs against a newspaper.

So, first of all, the teacher can say, 'In Problem 5, when we experimented with the four-straw pipe, the cotton swabs flew quite a long way. In this experiment, a newspaper is in front of that distance, so let's see what happens.'

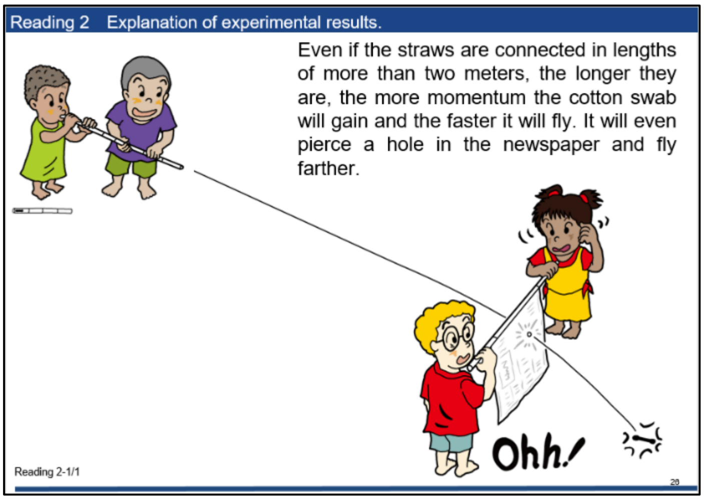
Then, the teacher shows that the cotton swab from the 4-straw pipe bounces back or pierces through. Next, experiment with the 8-straw pipe.

Problem 7-4/4



►The teacher checks with the student how far the swab has flown through the newspaper to the other side and declares the result. Then, continue to the next page.

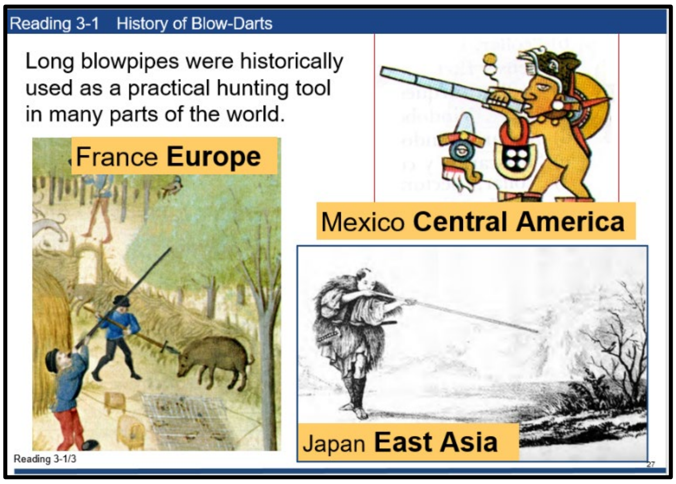
Reading 2-1/1



►Read the explanation of experimental results.
The longer time a cotton swab is pushed, the more momentum it gains and the faster it flies. It can also fly farther through a hole in the newspaper.

►No need to explain here, but in practice, when the length of the blowtubes is longer than about three meters, it reaches its limit due to the inability to hold its breath and the increased air resistance.

Reading 3-1/3



Reading3-2/3

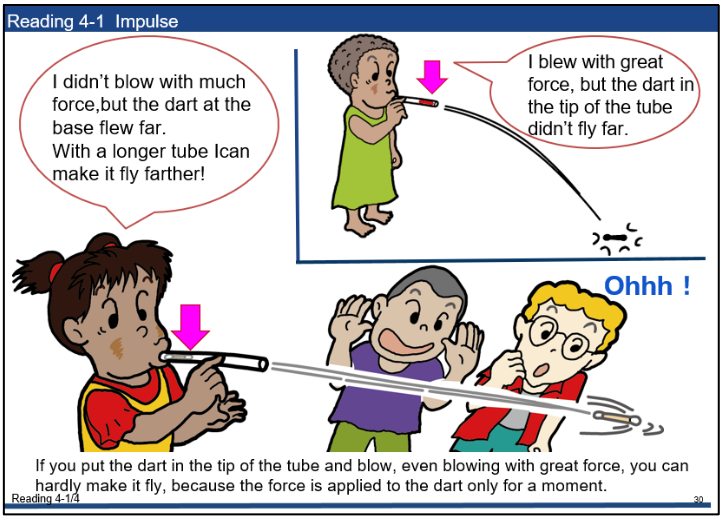
►There are records of the use of blowguns as hunting tools in many parts of the world. People devised techniques to make long, straight tubes. Besides using the plants as they were, people formed a tube in some areas by pasting together thin boards.

Reading 3-3/3

►Photo**1**. Playing with a straw blowgun is expected to promote muscle development around the mouth and has been incorporated into eating and speech training for children and older people.

Photo **2**. The sports wellness blow-darting, which uses a 120 cm long fibreglass tube with a 1.3 cm inner diameter and plastic arrows, was developed by respiratory physicians in Japan. It is becoming popular internationally as a sport that people of all ages can enjoy, and international competitions are being held.

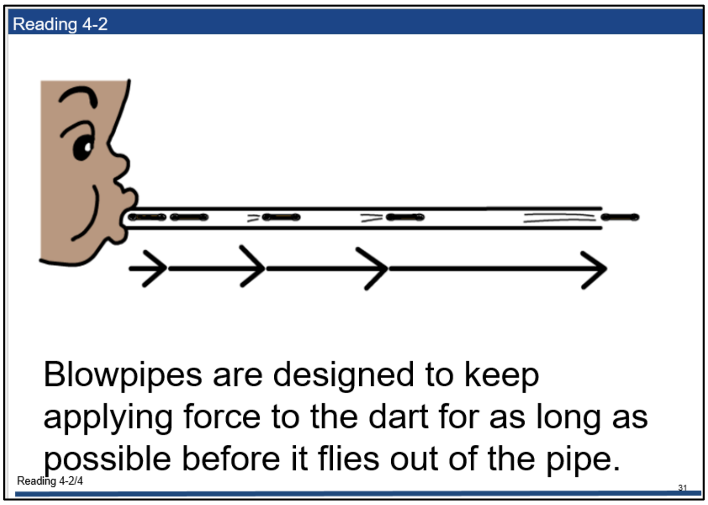
Reading 4-1/4



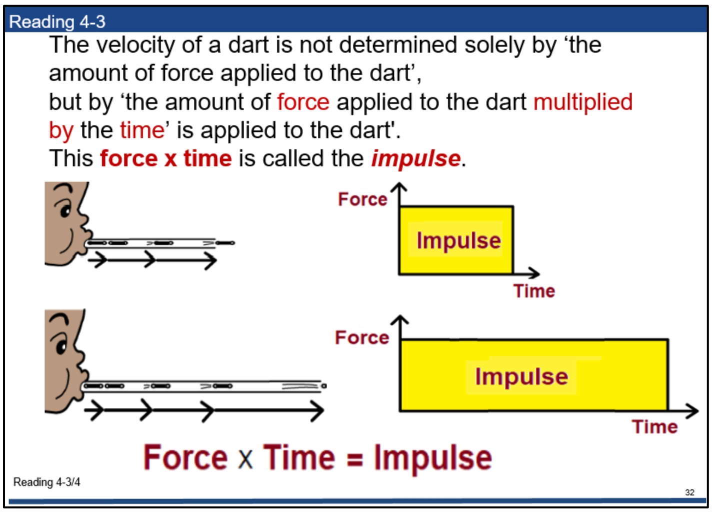
►No matter how powerful a person is, if they put the swab in the tip of the tube and blow, it will only have a momentary force applied and will hardly fly away.

However, even those who are not very strong can fly further by blowing the cotton swab at the base. Also, if the blowing pipe is more prolonged, force can be applied to the swab for a more extended time, allowing it to fly much further.

Reading 4-2/4



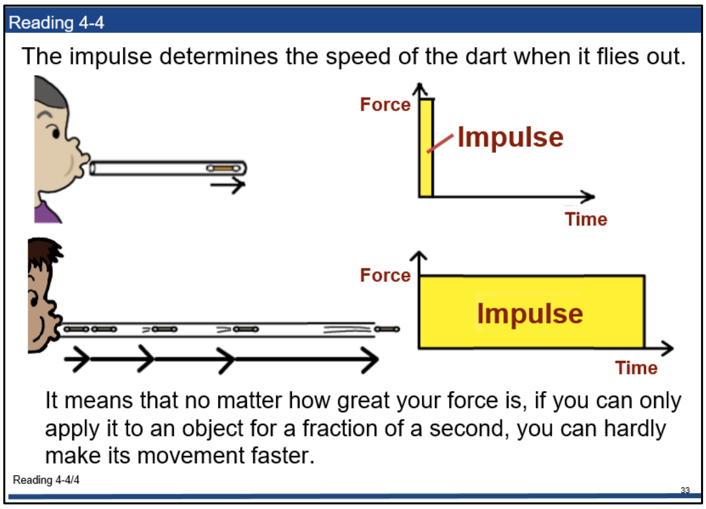
Reading 4-3/4



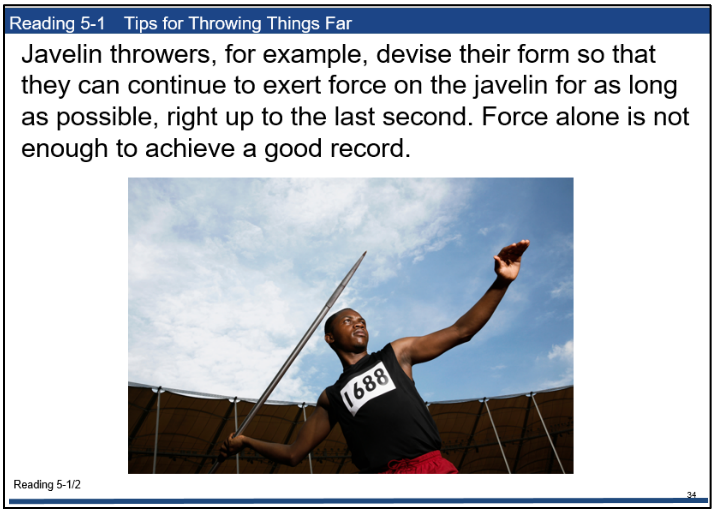
►'**Impulse**' is a new scientific term for students. The teacher may read it aloud slowly and repeatedly, allowing time for students who want to take notes or ask to pronounce the words.

►If students are not familiar with graphs, have them intuitively compare the size of the areas of the yellow areas. You may explain that this chart visualises the magnitude of the invisible Impulse. Briefly explain that the vertical width represents the same force and that the figure extends horizontally and increases in area as time increases.

Reading 4-4/4

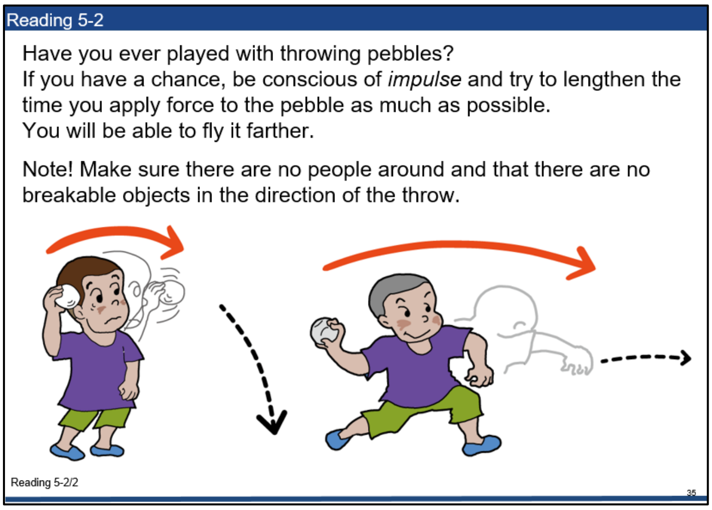


Reading 5-1/2



▶The arm holding the spear is pulled far back before starting the throwing action, which has the effect of lengthening the time it takes to release the spear from the hand. The same meaningful action can be seen when throwing a baseball or hitting a tennis or badminton ball. Using examples from sports or other activities that students are familiar with is also a good idea to illustrate this.

Reading 5-2/2



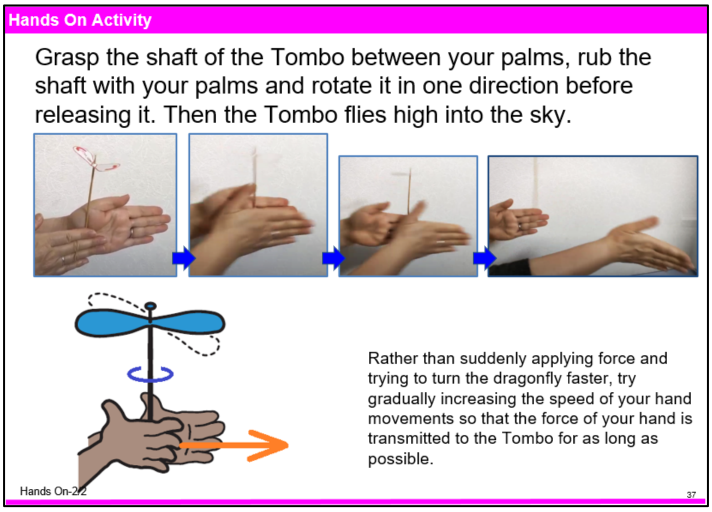
▶If students are familiar with baseball, they will remember it.

Hands-On -1/2

►The instructions on how to fly are on the next page.

►For teachers, see the last page of this guide for detailed instructions on materials and how to make and fly. This toy, originally made of bamboo, is a Japanese toy called a bamboo dragonfly.

Hands-On -2/2

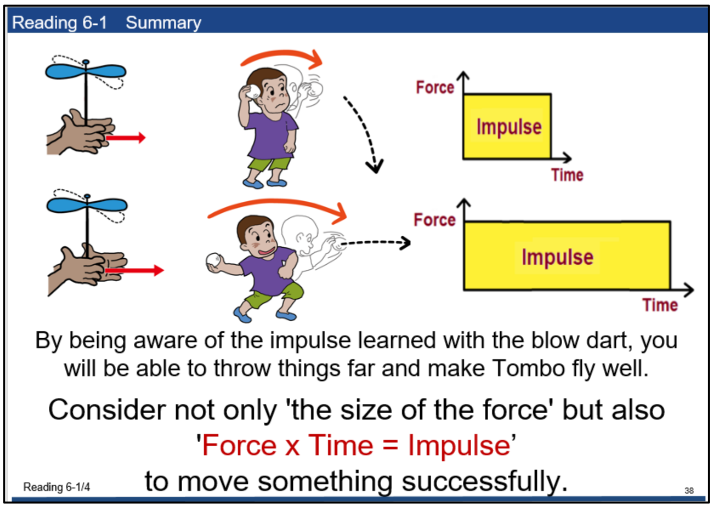


►First, the teacher should show the students how to fly it in practice. Show them that different times of application of force for the rotation of the axis result in a different flight.

►Students are not used to flying Tombo, so they tend to try to rotate it rapidly from the start, but this does not make it fly very well. If they are conscious of using the whole palm of their hands, slowly at first, then rubbing them together for a long time, the rotation will gradually speed up, and the toy will fly well.

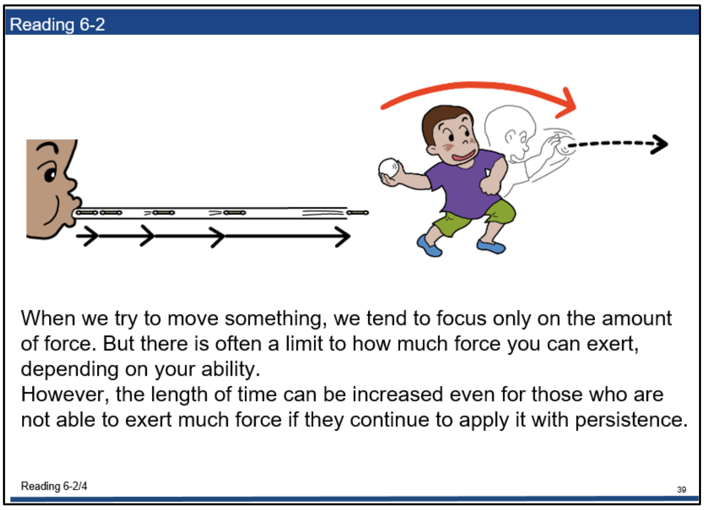
►Watch and talk to the students and help them enjoy the trial-and-error process.

Reading 6-1/4

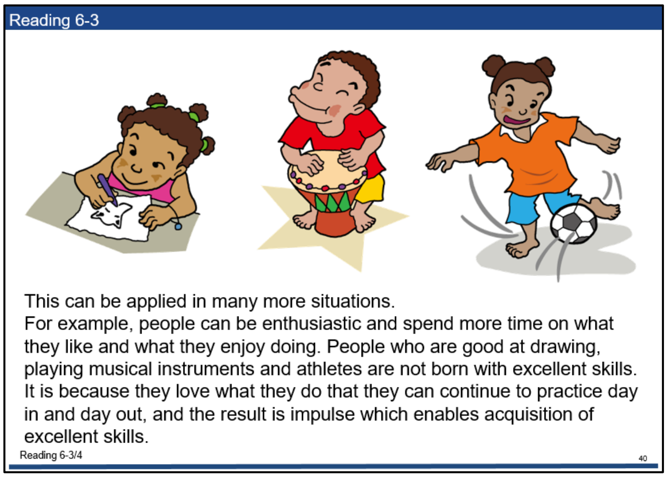


►Encourage students to think in terms of **Impulse** by recalling the examples of previous experiments and stories that have worked and those that have not.

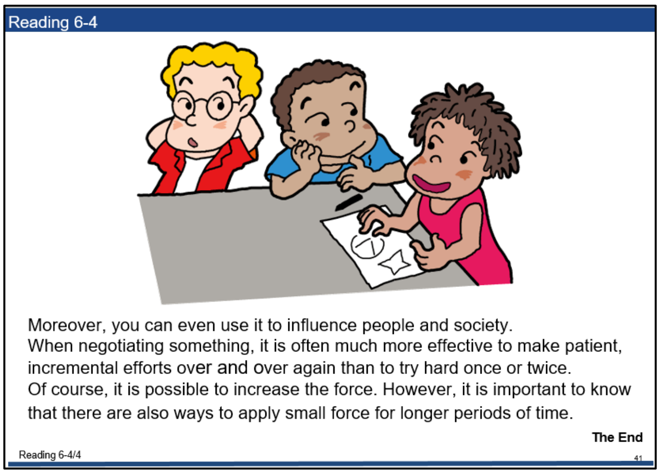
Reading 6-2/4



Reading 6-3/4

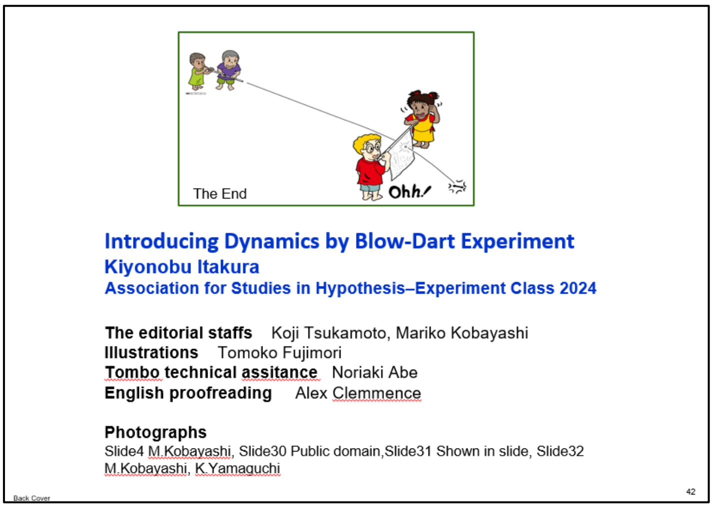


Reading 6-4/4



►When reading this story, there is something teachers should keep in mind. Applying the impulse concept to human life is simply one option for dealing with things. Be aware that it is just a suggestion that people can choose to do things this way. Please be careful not to impose ideas such as 'this will always work' or 'you must never stop trying.'

End cover



After Class

At the end of the class, ask each student to rate their enjoyment of the class on a five-point scale and to write down their impressions.
Moreover, the teacher will ask students to write their comments and feelings freely about the whole class.
These comments will not affect students' academic grading.

How did you find the lessons?

5 – It was very enjoyable.
4 – It was enjoyable.
3 – No strong opinion either way.
2 – It was boring.
1 – It was very boring

We consider the Hypothesis–Experiment Class a success if most students rate the class a 4 or 5, even if some gave 1 and 2 as exceptions.

We would appreciate it if you could provide the Association for Studies in HEC (ASHEC) with a record of your class (the Classbook title, target age group, country/region, students' impressions, number of students on each 5-point scale, your impressions as a conductor, etc.). Your report is valuable and needed to improve the HEC Classbooks.
For queries, please email contact_ashec@kasetsu.org.

Suppose there are many reports of low student evaluations. In that case, ASHEC will consider the possibility that the order or content of the Problems in the HEC Classbook may be inadequate. We will begin preparing revisions.

How to make a Tombo

What is a Tombo?

Tombo is a traditional Japanese toy called Take-Tombo, which was initially made from Take(bamboo). This easy-to-make version uses plastic sheets invented by Masaki Ando, and we use the stencil by Noriaki Abe. We have named this ‘Tombo’ as an international version.” Interestingly, Tombo commonly means the insect dragonfly in some African regional languages and Japanese.

Materials

PP or PET sheet

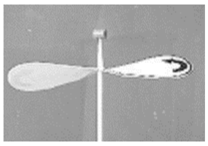
Prepare a sheet about 1 mm or less thick that can be cut out with scissors.

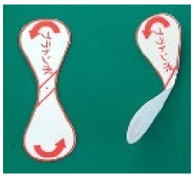
PP File folder covers or PET beverage bottles without complex surface irregularities can be used.

Skewers for the shaft

About 15-18 cm long and 2-3 mm thick sticks made of thin, rigid material such as bamboo or wood.

Handle the skewers with care, as they have sharp ends. After attaching the wing, cut off a little of the pointy end. Or, if you have soft beads, you can stick the tip into the side of a bead to cover it.



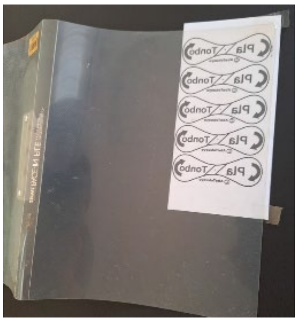


How to make a Tombo

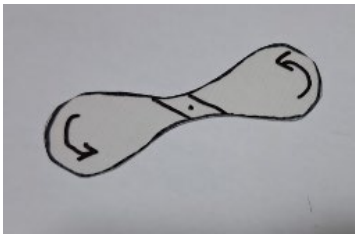
▶Video https://www.youtube.com/watch?v=QRMeAhzcs7Y

To make a Tombo using a PP file cover

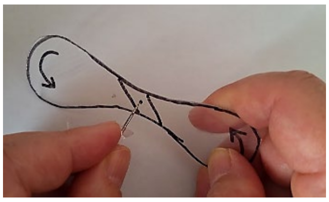
1) Lay the pattern paper (see next page) under the plastic sheet and trace the outline and fold lines. (or cut out the patterned paper and place it on the sheet to trace the shape outside).



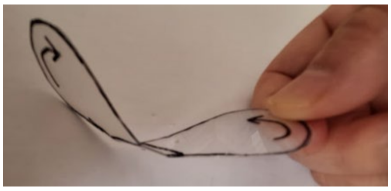




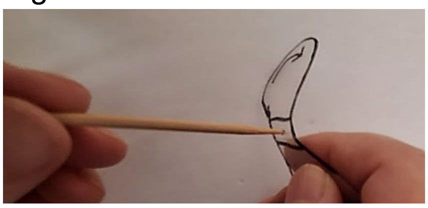
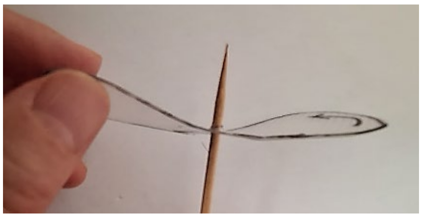
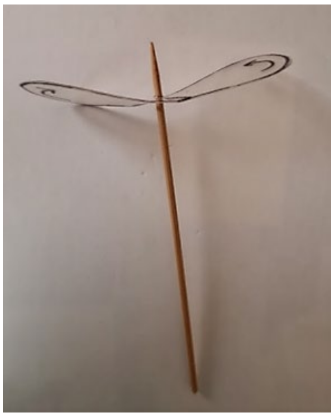
2) Punch a hole in the centre point by firmly sticking a drawing pin or similar into the hole.



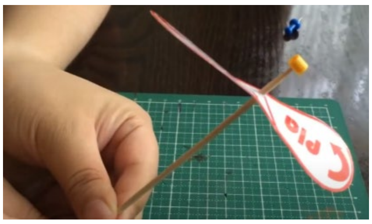

3) Place a ruler or similar object on the diagonal line and fold the blades on both sides upwards along the line.

4) Turn over and stick the skewer firmly through the hole in the middle until the tip sticks out about 2cm or more. It flies better when the shaft above the wings is long enough.

5) Handle the skewers with care, as they have sharp ends.
After attaching the wing, cut off a little of the pointy end. Or, if you have soft beads, you can stick the tip into the side of a bead to cover it.



To make a Tombo using PET bottles

The process is almost the same as when made with PP sheets.


PET bottles with a less uneven surface and not too thin material can be used.

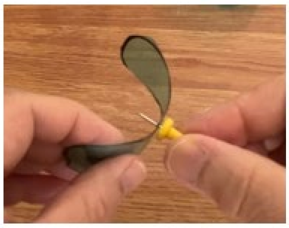
The bottles with deep surface irregularities and thin material cannot be used.

1) Cut open the body of the bottle to make a sheet.

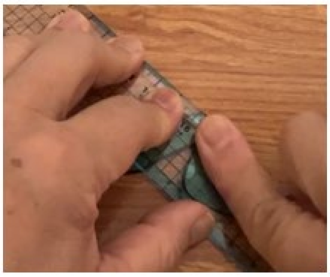
2) Place the sheet on the pattern with the mountain side of its curved surface facing up and copy the propeller's outer frame, centre point, and fold line.


3)Cut out the propeller and pierce a hole in the centre point with a pin.

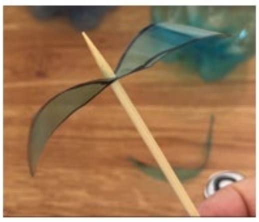




4) Place a ruler or similar object on the bend line and bend a propeller firmly towards the front. Then, bend the other side towards the front in the same way.

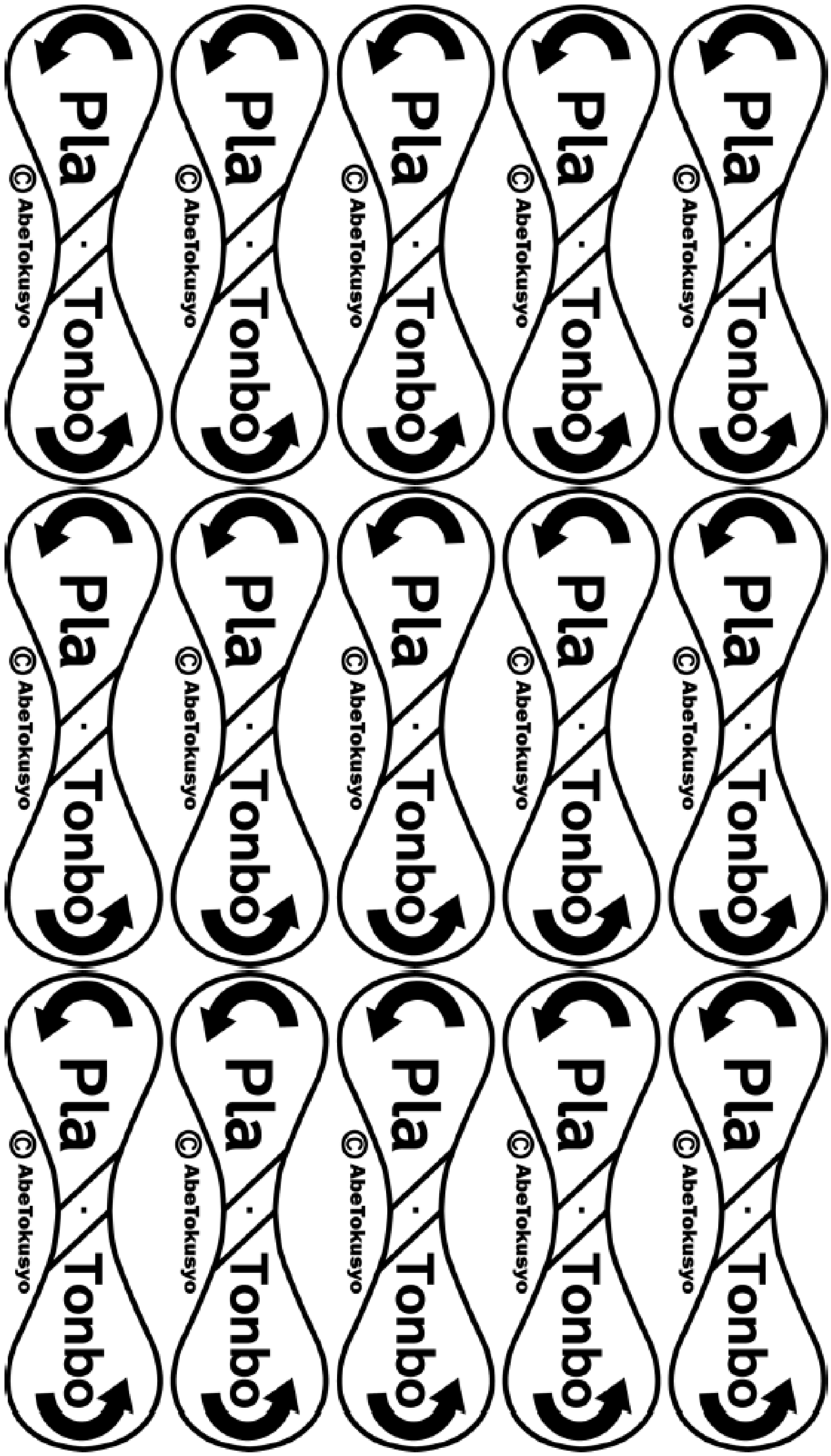







5) From the underside of the curved surface, stick the skewer firmly into the hole until its tip protrudes at least 2 cm from the hole in the middle.

Tombo pattern paper



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Teachers' Guide for Hypothesis–Experiment Class
Introducing Dynamics by Blow-Dart Experiment

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