**Big fish, little fish**

Particles of water move quickly in all directions.

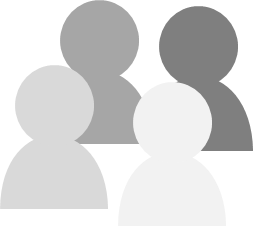
The pressure water has is caused when particles push each other apart.



Some students are talking about the effect of pressure on the shark and on the small fish.

**Charlie:** The pressure on the shark is the same as the pressure on the small fish.

**Drew:** The shark needs to be stronger than the small fish so that it isn’t squashed.



**Edward:** The water presses on the shark with more force than on the fish, because it has a bigger surface.

**Fatimah:** The force on each 1cm2 of the shark is the same as the force on each 1cm2 of the small fish.

**To answer:**

1. Who is right about the effect of pressure on the shark and the fish?

*Explain your answer*

1. Who is wrong about the effect of pressure on the shark and the fish?

*What would you say to help them understand?*

|  |  |
| --- | --- |
| Cards for  **Big fish, little fish** |  |
| **Charlie:** The pressure on the shark is the same as the pressure on the small fish. | **Drew:** The shark needs to be stronger than the small fish so that it isn’t squashed. |
| **Edward:** The water presses on the shark with more force than on the fish, because it has a bigger surface. | **Fatimah:** The force on each 1cm2 of the shark is the same as the force on each 1cm2 of the small fish. |

|  |  |
| --- | --- |
| Cards for  **Big fish, little fish** |  |
| **Charlie:** The pressure on the shark is the same as the pressure on the small fish. | **Drew:** The shark needs to be stronger than the small fish so that it isn’t squashed. |
| **Edward:** The water presses on the shark with more force than on the fish, because it has a bigger surface. | **Fatimah:** The force on each 1cm2 of the shark is the same as the force on each 1cm2 of the small fish. |

*Physics > Big idea PMA: Matter > Topic PMA4: Particle explanations > Key concept PMA4.2: Pressure*

|  |
| --- |
| **Response activity** |
| **Big fish, little fish** |

**Overview**

|  |  |
| --- | --- |
| Learning focus: | The pressure of a fluid is a measure of how hard its particles are pushing each other apart, and it is proportional to the size of the force exerted by the fluid on a surface. |
| Observable learning outcome: | Distinguish between pressure and force. |
| Activity type: | Talking heads |
| Key words: | Pressure, force, particles, surface area |

This activity can help develop students’ understanding by addressing the sticking-points revealed by the following diagnostic question:

* Diagnostic question: Doubling up

**What does the research say?**

Psillos (1999) examined how textbooks develop an understanding of pressure and found that they nearly always introduce pressure as a measure of how concentrated a force is and use the equation ‘P=F/A’ to define it. Usually, examples of solids pushing down onto a surface are used to consolidate understanding and in these examples surface pressure is a vector quantity acting in one direction. From such an introduction, students can interpret pressure wrongly as a ‘pressing force’ and may (as some textbooks do) describe a fluid ‘exerting a pressure’. This misunderstanding is compounded by diagrams that usually indicate pressure with arrows that are visually indistinguishable from force arrows. It is instead, correct to say that ‘a fluid has pressure’ and a ‘force is exerted’ (Kariotoglou and Psillos, 1993).

In order to think about pressure in liquids and gases, students cannot simply extend ideas about surface pressure (Driver et al., 1994). In contrast to pressure between solid surfaces, pressure in a fluid is a scalar quantity, yet few students think of pressure acting in all directions in air or water and textbooks rarely make explicit the conditions in which each interpretation of pressure should be applied (Psillos, 1999).

**Ways to use this activity**

This task is intended for discussion in pairs or small groups. It can be done as a pencil and paper exercise or projected onto a screen.

Students should read the statements and follow the instructions on either the worksheet or the PowerPoint. Listening in to the conversations of each group will often give you insights into how your students are thinking. Each member of a group should be able to report back to the class.

Feedback from each group can be used, with careful teacher questioning, to bring out a clear description or explanation of the science.

*Differentiation*

The quality of the discussions can be improved with a careful selection of groups; or by allocating specific roles to students in the each group. For example, you may choose to select a student with strong prior knowledge as the scribe, and forbid them from contributing any of their own answers. They may question the others and only write down what they have been told. This strategy encourages contributions from more members of each group.

NB in any class, small group discussions typically improve over time and a persistence with this strategy is often very successful in the medium to long term.

**Expected answers**

1. Charlie, Edward and Fatimah are all correct.

The pressure is caused by water particles pushing each other apart and is depends on how hard and how often water particles collide with each other. Pressure is independent of the shark or the small fish.

When a fish is in water it has a surface that water particles collide with from the outside. The shark has a larger surface area than the small fish, which allows more water particles to collide with it each second. The water therefore exerts a bigger overall force on the shark.

Water around the shark is at the same pressure as water around the small fish, so water particles collide with each one in the same way. Particles will hit each square centimetre of either one with the same average speed, the same frequency, and therefore with the same sized force.

2. Drew is wrong.

The pressure of water around the shark and the small fish is the same, which means the force per unit area pushing against each is the same. Each unit area of surface of the small fish and the shark needs to be equally resilient to squashing.

(It could be argued that because the shark has a smaller surface area per unit volume it does not need to be as strong as the small fish to withstand the forces exerted by the water.)

**Acknowledgments**

Developed by Peter Fairhurst (UYSEG).

Images: Peter Fairhurst (UYSEG).

**References**

Driver, R., et al. (1994). *Making Sense of Secondary Science: Support Materials for Teachers,* London: Routledge.

Kariotoglou, P. and Psillos, D. (1993). Pupils' pressure models and their implications for instruction. *Research in Science and Technological Education,* 11(1)**,** 65-108.

Psillos, D. (1999). Teaching fluids: intended knowledge and students' actual conceptual evolution. *International Journal of Science Education,* 21(1)**,** 17-38.