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Helping primary pupils develop concepts in science

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In primary Science teaching, it is very important for teachers to be able to explain concepts clearly so as to promote intellectual understanding in their students. Such a process between teacher and pupil can be seen in question-and-answer time, when the teacher explains concepts and pupils question to test their understanding. Clarity of explanation is of great importance in this case.

I. Clarity of Explanation

Consider the following authentic examples which are taken from the actual interactions between the teachers and their pupils. These sometimes syntactically inaccurate but communicatively effective interactions are not uncommon in Singapore given the fact that English is not the first language for the majority of pupils.

Example 1:

Teacher A: ... Pong pong tree is very big. You can see the leaves. They are the same. The leaves are the same shape, like the mango tree. What shape is it?

A few children: Oval shape.

Teacher A: Oval shape. The leaves are similar to the mango tree... mango leaves, oval shape. The fruit is round like the apple, green when it is unripe. And what colour does it turn to when it is ripe. Some of you have seen it. What colour?

A boy: Red.

- Teacher A: Red colour. Turns red when it is ripe. Inside when you cut open, what can you find in the fruit... Can you eat the seeds?
- Some children: No.
- Teacher A: Why?
- Children: Poisonous.
- Teacher A: Poisonous. If you eat the seeds means you say bye-bye, (some children laugh, others smile) because they are poisonous huh! You see, the seeds are poisonous, so you can't eat it, huh! All right. The mango tree, also similar to the pong pong. Another similarity is that mango tree is, what kind of shape has it got? Yes (pointing to a girl.)
- Girl: Oval shape.
- Teacher A: Oval shape, no. What shape has a mango tree got?
- Boy: Round shape.
- Teacher A: Round shape, yes. Mango tree, also round shape.

Example 2:

- Teacher A: The baby is developed... the egg is developed inside the body, inside the mother's stomach, until the time is up and then the mother will give... they don't lay eggs, they give...
- Some children: Birth.
- Teacher A: ... Birth to the young ones.

These incidents caused uncertainty in pupils' understanding of the concept Teacher A was intending to convey to the pupils.

It is interesting to note what Minah, a Primary 4 pupil from Teacher A's class, said:

- Minah: Mr A said for mammals the eggs developed inside the mother's stomach. If it is like that, then all the food the mother eats, and all the water the mother drinks all go inside the stomach. How? The baby will be buried under the food. Can the baby die?

Sheena, Minah's classmate, responded:

Sheena: I think, for mammals, inside the mother's stomach, got one side for keeping the baby, and one side where the food goes.

Inconsistency in conceptual explanation can be found in Teachers A and B. Two examples are given below.

Teacher A: (Picking up a sample of bark-rubbing) I take this because this came out very nicely. You can see the dark patches. Can you see the dark patches?

Some children: Yes.

Teacher A: These are the cracks. The places where it's very rough... then it comes out like these dark patches, when you shade...

Teacher B: (Picking up a sample of bark-rubbing) When it is very rough, you get some white patches, because you can't do the bark rubbing... If you see a lot of white patches, that means the trunk is very rough.

From the above vignettes, while Teacher A told pupils that "the place where it's very rough... it comes out like these dark patches", Teacher B told her pupils that "if you see a lot of white patches, that means the trunk is very rough." Both teachers were referring to samples of bark rubbing.

This contrast in statements will produce confusion to anyone sitting in on both lessons, not to mention the argument over which answer to accept if such a question appeared in an examination paper. The confusion could be removed if, say, Teacher B had explained that the white patches were caused when the bark had deeper and wider grooves, and so in bark rubbing the pencil jumped over the hollowness of the grooves, and because the hollowness of the grooves were not shaded, they appeared as white patches.

In the same lesson, Teacher B had intended to get students to bark-rub two different trees – a rain tree and a mango tree. However, it was not specified except that they "must do two trees", with the

result the students each had two specimens of bark-rubbing from two mango trees instead.

Another incident worth mentioning is Example 3.

Example 3:

- Teacher C: Can you describe the seed? (referring to a rambutan seed.)
- Jingyi: The seed is brittle and hard, but can bite through.
- Teacher C: All agree, it's brittle and hard?
- Children: Yes.
- Teacher C: The seed is brittle and hard. What else?... Would all these... would just the colour and seed have any way in which they help in the dispersal?
- Children: No.
- Teacher C: No. People and animals help in this kind of dispersal. How?
- Some children: They throw away the seeds.
- Teacher C: Why?
- A few children: So that they can grow new plants.
- Teacher C: Yes, but there's something else... who knows? ... Why do these people and animals throw away the seeds? Why don't they eat the seeds?
- Derrick: Difficult to swallow.
- Teacher C: Yes, difficult to swallow... yes, something else... Why is it difficult to swallow?
- Children: Because it's too big to swallow.
- Teacher C: Yes...because the seed is quite big and hard... So therefore these fruits are eaten by people and animals, and you've found out that these seeds are big and hard, so that they have to be thrown away. Can you give me some more examples? Some more examples of fruits that have big and hard seeds?

- Some children: Durian.
- Teacher C: Durians, yes what else?
- A boy: Water melon.
- Teacher C: Okay water melon, sometimes when you eat water melon, you accidentally swallow the seeds...
- Same boy: Mango.
- Teacher C: Mango, yes.
- A girl: Jackfruit.
- Teacher C: Jackfruit, yes...

Among the list of fruits like durian, mango and jackfruit given in this incident, water melon was also accepted. More confusion was presented when Teacher C said, "Okay water melon, sometimes when you eat water melon you accidentally swallow the seeds."

In the Student Interview after the lesson was taught, it was found that John, a pupil from this class, was actually confused.

Facts which are half explained or not explained often leave pupils in a bewildered state of mind. Consider, for example, the incident below from the lesson on 'Different ways of Reproducing Plants', taught by Teacher C.

Example 4:

- A boy: Fish water... My mother always put fish water into the soil.
- A few children: Huh, fish water?
- Teacher C: Yes, fish water contains a lot of nutrients for the plants.
- Roy: What fish, Teacher?
- Teacher C: Any fish.
- Roy: What? (looking confused).
- Teacher C: After buying fish from the market and before cooking the fish, your mother has to wash the fish, right?

Children: Yes.

Teacher C: After washing the fish, sometimes your mother uses that water for watering the plants.

Roy: Oh, but so smelly.

Only when pupils are clear of the teacher's explanation or instruction would they then respond in a happy and contented manner, like Roy, who said, "oh, but so smelly" when he finally understood what 'fish water' was about.

Also in any 'argument' it would be helpful if the teacher could guide pupils on to consider all the possibilities that would lead them to a logical and agreeable conclusion, as in the case of Teacher D, who during the lesson on 'Food Webs' (see Example 5) had two groups of students, one who said that eagles can eat pythons and the other who said eagles cannot eat pythons.'

Example 5:

Teacher D: Okay, we have an argument about python eaten up by eagle. Our argument is... Can an eagle eat a python?

A boy: Because it all depends on the size of the python.

Teacher D: Very good. It all depends on the size of the python. Imagine a 10.6 metre python, you think an eagle can eat it?

Children: No.

Teacher D: No. Pythons come in various sizes, but more often than not, when you think of pythons, you think of long snakes... or short snakes?

A boy: Short.

Teacher D: Short?

Children: Long.

Teacher D: Yes, a long fat snake, you understand. You think of a snake that will coil around you.

II. Expansion of 'Knowledge'

Often when teachers avoid responding to pupils' ideas or questions, in their bid to cover what they only intend to cover for the lesson, they not only cause disappointment to the pupils but also miss the opportunity to expand pupils' conceptual understanding. An example is provided by Teacher E.

Example 6

- Teacher E: So what makes use of stored air?
- Children: Football.
- Teacher E: Yes, anything else?... Just football?
- Some children: Basketball.
- Other children: Netball.
- June: Sepak Takraw. (Sepak Takraw is a game usually played by Malay boys. The ball is made of cane woven together.)
- Teacher E: What?
- Some children: No.
- Teacher E: You look at a sepak takraw ball and a football. Is there a difference between the two?
- Jawin: One is made of cane, got many holes.
- Teacher E: Yes, if it has many holes, can it store air?
- Children (laugh): No.
- Teacher E: No, right? Only basketball, netball, football, volleyball... these balls make use of stored air. How do we fill them up with stored air?
- Children: By pumping them.
- Teacher E: Yes, June, do you pump air into the sepak takraw ball?
- Children: (They laugh, including June.) No.
- Teacher E: No. So you understand what kind of balls make use of stored air. Are there any other things that make use of stored air besides the oxygen tanks in hospital and balls...

Binyan: Beach ball...
Melissa: Car tyres...
Another girl: Bicycle tyres...

If Teacher E had not responded in the way he did, June and some of her classmates would still have the idea that a sepak takraw ball can be inflated with air just like a football, basket-ball, netball or volley-ball can.

Another incident which helped to expand pupil understanding is,

Example 7:

A boy : Teacher, why is it that a boat which is heavier than a a brick can float and brick cannot float?

Teacher F: Very good.This boy has asked... Why is it that a boat which is heavier than a brick, and yet the boat can float and the brick which is smaller than the boat cannot? Why? Who knows?

The boy: Because the water supports the boat.

Teacher F: The water supports the boat, sure?

The boy: (nodding his head) Because the boat is like that (gesturing) spread out, and the brick is not.

Teacher F: So you see, when you're doing science you can come out with a lot of questions, a lot of ideas...

Wendy: Teacher, teacher. I know why the brick cannot float.

Teacher F: Why?

Wendy: Because the brick has holes, then when you put it into the water, the air will escape and the water gets in and makes the brick heavier, just like if you make holes in the boat, the boat will sink, because the water gets into the boat.

Teacher F: So if you make holes in the boat, the boat will sink because the water gets into the boat. But let's say a solid with no holes:.. why does it sink then?

- Marcus: Teacher, try out with a stone, Teacher.
- Teacher F: All right, let's try out with a stone. Who has a stone?
- A girl: I have. (She takes it out of her pocket and gives it to the teacher.)
- Teacher F: A tiny little stone. (Teacher F drops the stone into the tank of water watched by the children. The stone sinks to the bottom of the tank.) So what happens? (Teacher F picks up the stone.) Just now you said because of the holes in the brick, the air escapes and the water goes in and makes the brick heavier, that's why it sinks. Now, are there any holes in this tiny little stone?
- Children: No.
- Teacher F: No, so no air escapes from this stone and no water gets in to make it heavier, how come it also sinks? (Teacher F drops the stone into the water again and the stone sinks to the bottom of the tank.) So?
- Some children: Depends on what kind of wood.
- Teacher F: Depends on what kind of wood. Okay let's try. (Teacher F has blocks of different wood and she drops each into the tank of water. They all float.) How about your pencil? (A boy offers his pencil and Teacher F takes it and puts it on the water. The pencil floats.) So anything made of wood will float. Now what about sand?
- Some children: Sink, sink.
- Teacher F: You say it will sink. How many of you say it will float?
- (No response from children)
- Teacher F: So you all say sand will sink. Right? (Teacher F puts some sand into the water, watched by the children. Very soon the sand settles at the bottom of the tank.) Now, what happens to the sand?
- Children: Sink.

Teacher F: The sand sinks, yet it is so light. So there are things that float and there are things that sink, and the reason is something that has to do with the water and the solid...

If Teacher F had not explained that "there are things that float and there are things that sink, and the reason is something that has to do with the water and the solid...", Wendy and perhaps her classmates too would continue to be deep in thought with surely it is "because the brick has holes... water gets in and makes the brick heavier, just like if you make holes in the boat, the boat will sink, because the water gets into the boat."

Consider also the biological accuracy when Teacher G told pupils that "for science we are classified under animals", and her encouragement of the right choice of words like 'bird droppings' rather than 'bird faeces.' This can be compared to the incidents from Teacher C's lesson under the same topic presented below.

Example 8:

Teacher G: For science we are classified under animals.
Some children: Ya.

Example 9:

Teacher C: Her answer... We people eat them (referring to rambutans.) All agree?
Children: Yes.
Teacher C: Only people?
Children: No.
Teacher C: No, who else eats them?
Children: Animals.
Teacher C: Besides people, animals. eat this fruit... People and animals help in this kind of dispersal...

Example 10:

Teacher G: We don't say bird faeces. We normally say bird droppings because that's exactly what the birds do... Drop them anywhere they like.

Example 11:

Teacher C: These birds when they swallow the seeds, because the seeds are hard, they are passed out as bird...

A few children: Waste matter

Teacher C: Yes, another example of a plant where the seeds are carried by birds is a buah ceri plant. The seeds are hard and are undigested and so are passed out of the birds' body together with the bird's faeces, and if they are dropped on some soil they will start to grow...

Conclusion

From the above examples, it can be seen that when the teaching is fragmented and disconnected children begin to form their own ideas, such as in the case of those children who spoke about the compartments within the stomach. Even when children have hands-on experiences, they may not necessarily be provided with the type of experience that will lead them to understand fully the concepts being presented. What is important is the quality of interaction between the teacher and her pupils, so that, together with hands-on experiences, a better understanding of science concepts and a mastery of intellectual skills can be achieved.