Letting children think things through for themselves

Neeraja Raghavan

This month, I would like to bring to you a research paper that emerged from my own classroom experience.

About a year and a half ago, I was invited to Rajghat Besant School (KFI), Varanasi, to spend a couple of weeks working with teachers and students. This paper describes a set of two double-period Science classes that I took for Class VI.

I was invited to teach the Archimedes Principle. When I asked the science teacher if the children had been introduced to terms like density, mass and volume, she replied in the negative. So I had to think of a way of using the four periods at my disposal to bring the children to some understanding of *why things float or sink, without getting them entangled in the definitions of these terms*.

It was my very first time to teach this topic in this way, and I had a great experience.

Since I would like you to read the paper for yourself, (it is freely downloadable from the link in the box below), I am not going to describe the pedagogy in detail. (For readers who prefer watching films to reading, a YouTube link to a short film that captures the gist of this paper is also given in the box below.) In essence, what I did was this:

Paper: *Teaching Archimedes Principle to sixth graders without teaching mass, density, pressure, volume or buoyancy* TEACHING SCIENCE, Vol 63 (3) Sep 2017, pp 39-48

Downloadable from: https://thinkingteacher.in/wp-content/uploads/2017/09/TS-63-3-article-Teaching-Archimedes-principle2.pdf

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Please visit the link: https://youtu.be/ceibN7vvkuk to watch a short film that summarizes the gist of this research paper.

- I had the children first think about why some fruits and vegetables float/sink, by writing down their predictions and their reasons for these predictions.
- After they did the above, I had them go out in pairs/small groups and try the actual experiments with fruits and vegetables, so as to verify whether or not their predictions were correct.
- Thereafter, I invited them to discuss their findings in the large group, so as to arrive at a consistent rule for *why things float or sink*.
- When we found that this was not happening (you will find details of this discussion in the paper), I began to tell them the story of Archimedes and the puzzle that King Hiero had put before him: that of finding out if the gold crown was made of pure gold or not, *without damaging it in any way*.

Now this is normally the point where, as a teacher, I would have told the students the definition of *density*

and explained how the *real mass* and *apparent mass* differ, so as to get them to see what determines whether an object floats or sinks.

Instead, I did something that I have never done so far: and I must confess, it was just an act of impulse.

I stopped the story at the point where Archimedes noticed some water being pushed out of the tub as he sank into it. I said that he jumped up with a discovery, shouting "Eureka!"

I did not tell them the discovery. Instead, I suggested that if any students wished to think this through for themselves, they could leave the class, while I continued with the story for the rest.

To my surprise, seven students rose and left the class.

I then adopted a different strategy to explain the forces operating on a body immersed in a fluid. Since I did not want to employ terms that were as yet unfamiliar to the students, I asked them if they had ever played the game *Tug of War*. They said that they had indeed played the game. When I asked them what usually happened in this game, they told me that there were two teams and that these pulled a rope in opposite directions.
"Who wins?" I asked.
"The team that pulls stronger!" came the immediate response.

Agreeing that this was indeed so, I explained that whenever there were two opposing forces acting on an object, any resultant movement would be in the direction of the stronger force. This was as true in the horizontal direction as it was in the vertical. Now, I drew a diagram on the board showing a circular object partially immersed in a fluid. When I asked which force was acting on this body in the downward direction, all of them chorused: "Weight!" I drew an arrow pointing down to depict this force.

I then drew the attention of the class to that part of the spherical body that was immersed in the fluid, explaining that it has to push aside some water *in order to make room for itself*. "This pushed aside water gets angry," I said smiling, "It says – *you pushed me? I'll push you back!"* And so saying, I drew an upward arrow that was opposing the downward force of the weight.

So, I explained, just like in the game of *Tug of War*, here were two opposing forces – so, the movement of the body would be downward if the weight (downward force) was stronger, and upward if the upward force was stronger.

The children were satisfied with this explanation and asked me if the goldsmith had indeed cheated the King. I recalled that no one had told us the end of this famous tale when we were in school, and informed the class that the goldsmith had indeed cheated the King of some gold.

The class ended and I left the room, only to find the seven students waiting outside: "*Didi*, we got the answer!" they informed me triumphantly.

When I asked them to explain it to me, I was astounded.

"The answer is this: just as Archimedes noted that some water got pushed out when he sank into the tub, he had to see how much water got pushed out when he dropped the crown into a bucket of water. Then, having measured this, he should have removed the crown, and dropped a lump of gold from the same height into the same bucket of water. He should have measured the amount of water that was displaced by the gold. If both amounts were equal, then the goldsmith has not cheated the King of any gold. But if they differ, then, the crown is not made of pure gold."

Reading the book of memories: teacher narratives: *Teachers' responses*

Teacher Plus would like to thank its readers who have shared their letters to their teachers based on the above mentioned article published in this column in the January 2018 edition. In order to accommodate them in the little space that we have edited them. To read their complete responses please visit www.teacherplus.org.

Respected Kumar Sir,

This is Reshma Kiran, a student of your 2009 batch. I hope you are doing well.

I am now working as a chemistry teacher in a residential school. You are the person who inspired me to take up a career in teaching. During my B Sc chemistry, your motivation and tips to learn the subject spurred me to choose this stream in my Master's as well. While teaching certain topics, I still recall vividly the ways that you adopted – teaching us using jokes, but at the same time, not sacrificing depth of coverage. Wherever you must now be teaching, I am sure that you must be enriching all the batches in the same way!

I will remain in touch with you.

Thank you for everything!

Yours respectfully,

Reshma Kiran
The Peepal Grove School
Sadum, Andhra Pradesh

Dear Babu Sir,

I fondly remember you, as that one teacher who has had a lasting impression on my life and career. Today, following your footsteps, I even teach geography to ICSE students.

We were scared of your classes because we knew we had to have revised properly or else we could be pulled up anytime! You never carried a textbook or notes for support. Although I never appreciated it enough then, I do now – especially now that I teach myself. Concepts were made clear so easily, with the help of simple diagrams. You were an expert!

Unlike students nowadays, I feel not having a textbook really helped in many ways. For one, it made us expert listeners and note takers. Our notes were our only source for exam preparation. To this day, these skills often come handy. It simply shows what an amazing teacher you were! This is a skill that I expect from my students too.

As a class teacher, too, you were strict, yet friendly. You keenly observed each one of us and helped us quietly to improve where required. I have never seen you mollycoddle anyone nor ever behave irresponsibly or irrationally. Of course, you would lose your temper sometimes and that definitely kept us on our toes.

I have everything to thank you for bringing this love for geography into my life and for having provided so many joyful memories of my school years. Some of my very best memories always have you in them. Thank you very, very much for everything.

I have wanted to contact you for the longest time but never got down to doing it. This is Vrinda here wishing you, your family and the entire Udyogamandal School Community, A Very Happy New Year!!

Hope to meet you sometime in this New Year.

With lots of respect, love and regards

Yours sincerely,

Vrinda Naidoo
The Peepal Grove School
Sadum, Andhra Pradesh

Dear Maths Teacher,

I am a student who was suppressed by your hard, harsh and meaningless words, which you thoughtlessly spoke without being aware of what happened that day.

I was sitting quietly and listening to your lecture. Suddenly, my friend (who was sitting behind me) asked me to move a little to the left, as he was not able to see what you had written on the board. So I turned to him, to tell him that I could not move, as then, *I* would not be able to see what you were teaching.

This was what happened that day.

While this exchange was going on, you started screaming: "What, girl! Why are you talking so much? I hate people who talk in classrooms! This is not a park to sit and chat! Mind you, this is a classroom! Just go out and talk how much ever you want! I don't want all these things to happen in my class!"

Without further ado, you turned me out of the class.

Even though I repeatedly requested you to hear me out

and cried, I was not able to convince you that I had not done anything wrong. You were in no mood to listen to me. You didn't even bother to ask the boy sitting behind me as to what was happening. I cried for nearly two hours because of the way you treated me for no fault of mine! That day you turned my desire and interest in maths into indifference. It was no longer my favourite subject.

You hurt me a lot, madam, without stopping to think about what this would do to a young girl.

I understand that teachers may/may not teach well, but they should never harm children's *desire to learn*. This letter is an important document for me to look at (and reflect on) my own behaviour in my classroom. I will never be the kind of teacher you were. I will always remember never to humiliate and dishonour my students. And for that alone I thank you.

Asha Y
RVEC, Bangalore

Barely able to contain my surprise, I asked them how much gold should be dropped into the water in the second experiment that they had described, or did the amount not matter?

With barely concealed impatience, one of the boys said, "He should drop *exactly the same amount of gold that was given to the goldsmith*, in the first place, to make the crown."

I was simply amazed.

Here was an actual experience of students reaching a stage where they had sensed that there was *some property that was common to the gold crown and pure gold*, but had not yet coined a name for it.

They were ripe to learn the definition of *density*, in my view.

The mistake that was made when I was taught this Principle was that the terms were first defined – and density is such an abstract concept that it took me a long time to grasp it. These kids were now ready to learn it, I realized.

Long after this episode, I wondered if this was a freak incident and so I tried the same approach again with a group of young teachers from Kerala. Again, in a group of 45 teachers, about four of them came up with the same reasoning that the seven students in my first class had.

This made me wonder: do teachers err by *telling too much* to our students? Do we skip the chance to let our students think things through?

This is what I would like to invite you to try this month. Please do go through the suggestions in the box below, and send in your responses as always.

Happy investigating!

Now bring it into the classroom!

1. Identify a concept that you have to teach and list out the steps in teaching it.
2. Plan a class that allows your students to *first express their own ideas* about this concept in a manner that brings out *their reasons for thinking the way they do*.
3. Then, teach the lesson by engaging with their hypotheses so that they are confronted with *the need to be consistent*, just as has been described in this research paper.
4. Throw open the option for students to think of ways of *resolving the inconsistency*.
5. See if any students get far in reasoning things out for themselves.

Please do share your responses to these suggestions at thinkingteacher22@gmail.com

The author is Founder Director of Thinking Teacher (www.thinkingteacher.in), an organization that networks with teachers across the country. Thinking Teacher aims to awaken and nurture the reflective practitioner within each teacher. By taking (action) research out of the classroom, Thinking Teacher develops the (action) researcher in the teacher. And then, by bringing research into the classroom – as in this series – Thinking Teacher's goal is to help build deep inquiry and rich learning into the teaching process. The author can be reached at < neeraja@thinkingteacher.in > .