那杯没化的糖，教会我控制变量

初二上学期，我在杯子里冲糖水，搅了半天，杯底还躺着一层糖。旁边那杯刚烧开的，糖下去几圈就没了。我盯着杯底那层白，冒出一个问题：糖化得快慢，到底跟水的什么有关？是温度，还是我搅的圈数？这个问题要是搁在以前，我会直接下结论：当然是温度。但那学期科学课正好在讲实验设计，我决定按课上的办法来一次。

我先把自己的猜测写下来：温度越高，糖化得越快。然后设计实验。要证明温度的作用，就得让别的条件都一样：同样的杯子，同样多的水，同样多的糖，同样的搅拌圈数，只有温度不同。我准备了三杯水，冷水、温水、热水，每杯二百毫升，每分钟加一勺糖、搅十圈。为了防自己耍赖，我把每一步都记在本子上，连水温用手试出来的冷热感觉也记了。

结果是热水到第九勺杯底才躺下糖粒，温水第七勺，冷水第四勺就不化了。我的猜测对了一半——温度确实有用，但我原来以为热水能化无穷多的糖，其实它也有饱和的时候。结论我写了两行：温度越高，糖化得越快，也化得越多；但每一杯水能吞下的糖都有上限。

这件事过去以后，我发现自己变了的地方不在厨房。背英语单词时，我老怀疑自己记性差。后来我把它当个问题做：两批难度差不多的词，一批睡前背，一批早上背，其他条件尽量一样，一周后互相测验。结果睡前那批记得牢。我没有再骂自己记性差，我只说：方法换了，结果就换了。这就是实验教我的——把模糊的抱怨变成一个能测的问题。

现在我做决定前会先问自己三句：我的问题是什么？我的猜测是什么？除了我要比的那个条件，别的条件一样吗？这三句是从那三杯糖水里带出来的。科学课会结束，实验器材会收进柜子，但这种把问题拆开、一项一项验证的思考方式，我觉得能带走一辈子。

The Sugar That Did Not Dissolve Taught Me to Control Variables

One morning in the first term of eighth grade, I was stirring sugar into a cup of water and stirred for ages, yet a layer of sugar still lay on the bottom. The cup beside it, just off the boil, swallowed the sugar in a few turns of the spoon. Staring at that white layer, a question popped up: whether sugar dissolves fast or slow - what exactly about the water does it depend on? The temperature, or the number of turns I stir? In the past I would have jumped to a conclusion: temperature, of course. But that term our science class was exactly on designing experiments, so I decided to do it properly, the way the class taught.

First I wrote down my guess: higher temperature, faster dissolving. Then I designed the test. To prove the role of temperature, everything else had to stay the same: the same cups, the same amount of water, the same amount of sugar, the same stirring turns, with only the temperature different. I prepared three cups - cold,

warm, and hot - two hundred milliliters each, adding one spoonful of sugar per minute and stirring ten turns. To keep myself honest, I recorded every step in a notebook, even the hot-or-cold feeling my hand judged the water by.

The result: the hot cup only showed sugar grains on the bottom at the ninth spoonful, the warm cup at the seventh, and the cold cup refused to dissolve anything past the fourth. My guess was half right - temperature does matter, but I had assumed hot water could dissolve unlimited sugar. In fact it has its own limit. I wrote the conclusion in two lines: the hotter the water, the faster and the more sugar it dissolves; but every cup has an upper limit on the sugar it can swallow.

After that, I noticed the change was not in the kitchen. When memorizing English words, I kept suspecting my memory was bad. Later I treated it as a question to test: two lists of similar difficulty, one recited before bed, one in the morning, other conditions kept as equal as possible, then a mutual quiz a week later. The bedtime list stuck better. I stopped scolding my memory. I just said: change the method, change the result. That is what the experiment taught me - turn a vague complaint into a question that can be tested.

Now before making a decision I ask myself three things: what is my question? what is my guess? apart from the one condition I am comparing, are all the others the same? Those three lines came out of those three cups of sugar water. Science class ends, the equipment goes back into the cabinet, but this way of thinking - taking a problem apart and checking it one condition at a time - is something I believe I can carry for a lifetime.

我推翻了自己的猜测，这比做对更值钱

科学课期末实践，我做的题目是绿豆发芽。开始之前我有个很硬的信念：豆子长得好不好，全看水给得够不够。我甚至给这个信念起了名字，叫水越多越好。结果三周之后，我亲手把这个信念推翻了。现在回想，推翻它的那三周，比我做对任何一道题都值钱。

我先老老实实把问题写清楚：水分多少，到底怎样影响绿豆发芽？再把猜测写下来：水越多，芽长得越好。然后设计实验。我用了六个一样的盘子，每盘二十粒绿豆，分成三组：第一组纸巾保持湿润，第二组每天浇到刚好积水，第三组几乎不浇水。六个盘子放在窗台同一个位置，豆子是同一袋里挑的，大小差不多。我在本子上写：唯一要比的是水，其他都得一样，不然结果说不清。

两周下来，湿润组二十粒出了十八个芽，又直又白；积水组出了九个芽，根尖发黑，有一股闷味；干旱组出了三个，芽矮矮的，头是黄的。我盯着积水组看了很久——那正是我原来认为待遇最好的一组。结论跟我的信念反着来：绿豆发芽要的水，是湿润，不是泡着。

我在实验报告里写：我的猜测被自己的数据推翻了。交上去本来有点不甘心，科学老师却在旁边批了一句：能被证据说服，是比结果更重要的收获。这句话我想了很久，慢慢品出了味道。以前我做题、跟人争论，都先把立场站好，再去找支持自己的说法。实验逼着我反过来：先定规则，再看数据，数据说不，我就得说否。

这个反过来，后来搬进了我的物理学习。错题本上我不再只抄正确答案，而是先写下我当时错的想法，再写证据为什么不容这个想法。有一次月考，一道浮力题我第一反应还是旧的直觉，笔停了一下，问自己：这个直觉经得起哪组证据检验？那一分最后拿住了。

实验教会我的科学思考，我总结成一句话：猜测可以大胆，但证据面前不许护短。一个人能被自己的实验推翻，还能服气，这大概就是科学留给人身上最耐用的东西。

I Overturned My Own Guess, and That Was Worth More Than Being Right

For the science final practical, my topic was sprouting mung beans. Before starting, I held a firm belief: whether beans grow well depends entirely on giving them enough water. I even named the belief - more water is always better. Three weeks later, I overturned that belief with my own hands. Looking back now, those three weeks of overturning were worth more than any test question I got right.

I first wrote the question honestly: how exactly does the amount of water affect mung bean sprouting? Then I wrote my guess: more water, better sprouts. Then I designed the test. I used six identical plates, twenty beans each, in three groups: the first kept its paper towel moist, the second got watered until water pooled every day, the third got almost none. All six plates sat in the same spot on the windowsill; the beans came from the same bag, picked to be about the same size. I wrote in my notebook: the only thing being compared is water; everything else must stay the same, or the result explains nothing.

After two weeks, the moist group had eighteen sprouts out of twenty, straight and white; the flooded group had nine, with blackened root tips and a stifled smell; the dry group had three, short sprouts with yellow heads. I stared at the flooded group for a long time - it was exactly the group I had believed was living the good life. The conclusion ran against my belief: the water mung beans need to sprout is dampness, not soaking.

In my lab report I wrote: my guess was overturned by my own data. I handed it in a little unwillingly, but the science teacher wrote beside it: being persuadable by evidence is a harvest more important than the result. I turned that sentence over for a long time and slowly tasted its meaning. Before, whether doing problems or arguing

with people, I would plant my side first and then hunt for statements that supported me. The experiment forced the reverse: set the rules first, then look at the data, and if the data says no, I have to say no.

That reversal later moved into my physics study. In my mistake notebook I no longer copy only the correct answer; I first write down the wrong idea I had at the time, then write why the evidence will not tolerate that idea. Once during a monthly exam, my first reaction to a buoyancy problem was still the old intuition. My pen paused, and I asked myself: against which set of evidence can this intuition stand? I held on to that point in the end.

The scientific thinking the experiment taught me, I sum up in one sentence: guesses may be bold, but no favoritism is allowed in front of evidence. That a person can be overturned by his own experiment and still accept it gracefully - that, I think, is the most durable thing science leaves in a person.

纸飞机比赛，我们组赢在提问

班级纸飞机比赛，我们组拿了第一。颁奖的时候，物理老师问我们：你们是不是天生会折飞机？我说不是，我们赢在先把问题问对。这句话不是客气，是我们三个星期前真的从乱试开始的。

第一次试飞，我们组四个人各折各的，扔出来的结果五花八门：有的栽跟头，有的飘得远。有人喊换这种折法，有人喊把头折重一点，场面一度像猜谜。我拦住他们，提了个建议：先别折，先想清楚我们到底在问什么。我们在纸上写：飞机飞得远，跟什么有关？能想到的写了一排——机翼宽窄、机头轻重、机翼上翘、折的层数、扔的力气。然后划掉扔的力气，因为比赛每人扔三次，力气没法比。剩下的每一项，都是一个能测的问题。

我们挑出最怀疑的两项：机头轻重和机翼宽窄。设计实验时，我们规定每次只改一处：同一张A4纸、同一种折法、同一个人站在同一条线后扔，量三次取平均。机头加一枚回形针，飞距从平均六米二变成七米四；机翼加宽两厘米，反而缩到五米八。两个结论都写进了记录本：适当加重机头飞得更远，机翼不是越宽越好。

比赛那天，我们用的是测出来的那一架：机头夹一枚回形针，机翼保持原宽，翼尖微微上翘。三次最好成绩九米一，第二名差了我们一米多。对手跑来看我们的飞机，翻来翻去说：看起来也没什么特别的。我说特别在数据里。

赛后我想了很久，我们真正的转折点是那次拦住乱试、先在纸上写问题。提出一个能测的问题，比急着动手值钱十倍。这个习惯后来跟到了我的学习里：数学难题先问自己卡在哪一步，英语阅读先问题目在问什么，都比上来就埋头省时间。连周末怎么安排，我也会先问：我到底想解决什么？

提出问题、设计实验、得出结论——课本上是三个短语，在我们组那儿是三周的纸飞机。科

学思考不是实验室里的仪式，它从一句先想清楚我们在问什么开始。

Our Paper Airplane Team Won by Asking the Right Question

Our team won first place in the class paper airplane contest. At the awards, our physics teacher asked: were you just born good at folding planes? I said no - we won by asking the right question first. That is not modesty. Three weeks earlier, we had truly started out flailing.

At the first test flight, the four of us each folded our own design, and the results went every which way: some planes nose-dived, some glided far. One shouted for a different fold, another for a heavier nose, and for a while it looked like a guessing game. I stopped them and made a suggestion: before folding, let us be clear about what question we are actually asking. On paper we wrote: what does a plane's distance depend on? We listed everything we could think of - wing width, nose weight, upturned wingtips, number of folded layers, throwing strength. Then we crossed out throwing strength, because in the contest everyone throws three times and strength cannot be compared. Every item left was a question we could test.

We picked the two we doubted most: nose weight and wing width. In designing the test, we ruled that only one thing could change at a time: the same A4 sheet, the same fold, the same person throwing from behind the same line, three throws averaged. Adding one paperclip to the nose took the distance from an average of 6.2 meters to 7.4; widening the wings by two centimeters pulled it back to 5.8. Both conclusions went into the notebook: a moderately weighted nose flies farther, and wings are not better the wider they are.

On contest day we flew the tested design: one paperclip at the nose, wings at their original width, tips turned up slightly. Our best of three throws was 9.1 meters, more than a meter ahead of second place. A rival came over, turned our plane over and over, and said: it looks nothing special. I said the special part is in the data.

Afterward I thought about it for a long time. Our real turning point was that moment of stopping the flailing and writing the questions on paper first. Asking a testable question is ten times more valuable than rushing to act. The habit followed me into my studies: for a hard math problem I first ask which step I am stuck at; for English reading I first ask what the question is asking. Both save time compared with burying my head in immediately. Even planning my weekend, I start with: what am I actually trying to solve?

Ask a question, design a test, draw a conclusion - in the textbook these are

three phrases; for our team they were three weeks of paper airplanes. Scientific thinking is not a laboratory ritual. It begins with one sentence: let us first be clear about what we are asking.