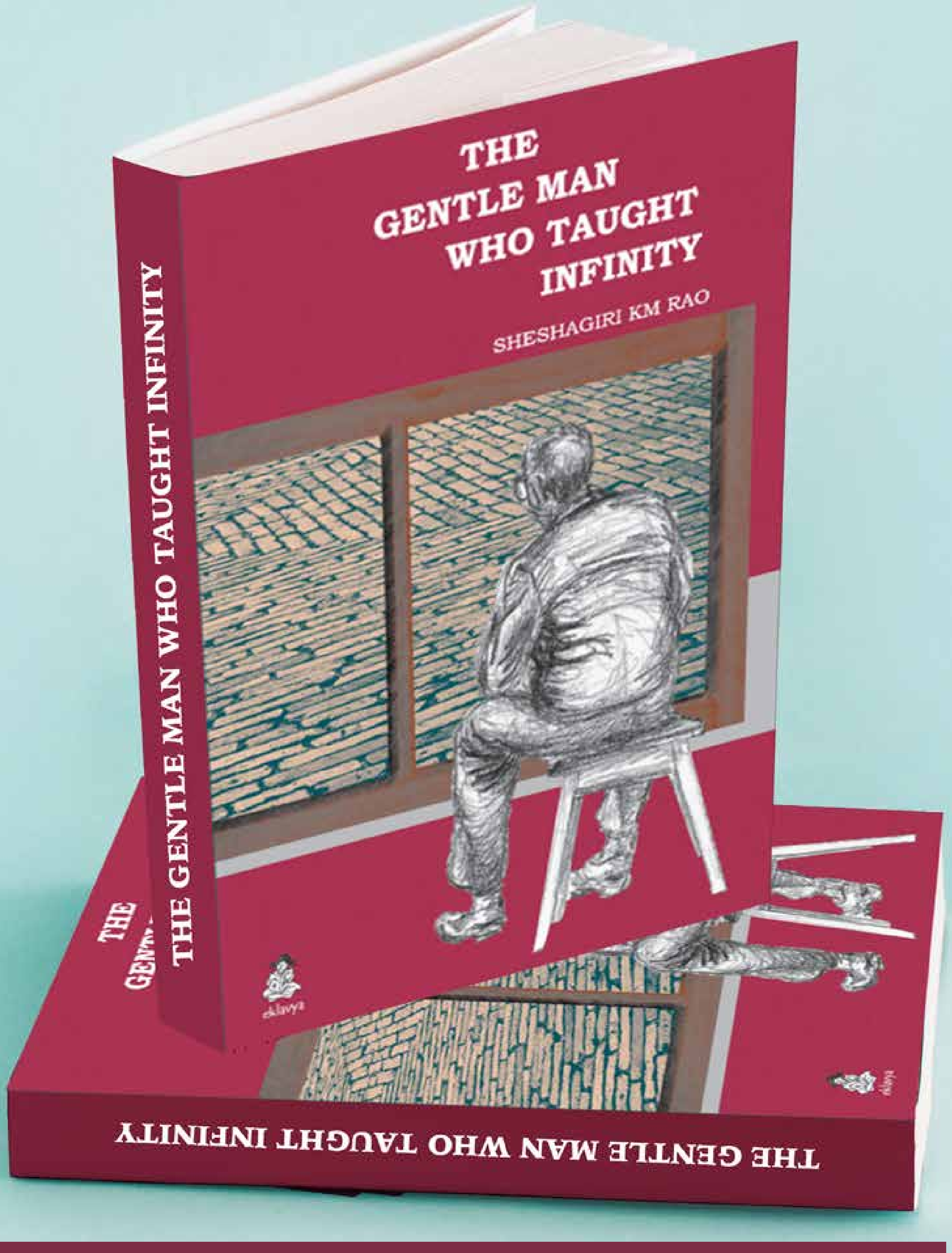

SHESHAGIRI KM RAO DESCRIBES THE NON-CONVENTIONAL TEACHING METHODS OF HIS HIGH SCHOOL MATHEMATICS TEACHER CHANNA WHO HELPED STUDENTS TO DISCOVER THE BEAUTY IN MATHEMATICS.

“How do you know that the three angles of a triangle add up to 180°? How do you know it is true?” Channa asked us with a straight face one day. This was in grade 8 after the first term. The question seemed simple and the answer obvious. But I could detect a mischievous intent as he posed the question. Little did I know that he was about to take us on a journey that was more than 2,000 years old, beginning with a chap called Euclid.

We had encountered the idea of a ‘proof’ along with the term ‘theorem’ for the first time when we were learning geometry, sometime in the middle of 1982. Till then, we had learnt some ‘basics’ in geometry - how to construct different kinds of triangles, find out the missing angles, how to bisect angles and lines, and so on.

Somewhere along the way, we had taken for granted the most common property of triangles - that the sum of the three angles of a triangle always adds up to 180°. This was sacrosanct.

I had always wondered how one had arrived at this number 180. Why not 246°, for instance? Anyway, I didn’t ask this question then and it took me years to realise why we choose 360° for a complete angle, 180° for a straight angle and so on. I now believe it is largely a matter of convenience, for the number 360 has a large number of factors that make computation easier.

“How do you know this is true?” Channa persisted.

“Measure and see, and you will get 180°,” many of us promptly responded. I remember being surprised by the question. It seemed so obvious then! And the protractors in our compass boxes were anyway made to show 180°. So how could we get anything else? The matter was therefore closed in my mind.

“How many triangles should one draw and measure?” Channa kept on.

This question stumped us a bit and I remember that we didn’t agree on any one number. In fact, any number would have been arbitrary - 10, 50, 100, 1000... The class fell silent after a while. Channa had a point and we were unable to get around it with our argument to collect data for as many triangles as we could. But I kept wondering: Could triangle number 1001 be different if the angles of each of the first 1000 triangles added up to 180°?

That was, indeed, his next question, “What if the angles of the 1001st triangle do not add up to 180°?” There was no response from the class. What was he trying to get at?

To drive home Channa’s point a bit, I must share another example, called the ‘Monstrous Counter Example’ that I came across recently. This thing called mathematics can be very unforgiving, as this example tellingly illustrates. Consider the statement: “The expression $\{1+1141n^2\}$, where ‘n’ is a natural number, never gives a square number.” A square number is a number like 25, because it can be written as 5x5, where 5 is called the ‘square root’ of 25. The term ‘square’ is used because 25 can also be represented geometrically as a square of 5 units by 5 units. You can think of several such square numbers, which are simply called squares.

When computers were used to check this expression, people found out that it did not yield a square number for any natural number from 1 till 30,693,385,322,765,65 7,197,397,20 7. This latter number is of the order of septillions, not millions, billions or trillions. Anyone could have then concluded that the expression $\{1+1141n^2\}$ will never yield a square number for all n. But - and this is downright crazy - the expression gave a square number for the next natural number! Can you figure out the square root then? Difficult to believe, right? Quite astounding, in fact. That is how the number world can startle you.

I remember Channa saying, “For this reason, we have to prove that no matter what, the three angles of a triangle add up to 180°.” So we went about proving this elementary theorem and learnt along the way that the word ‘theorem’ is nothing but a statement claiming such and such a thing, which has a proof that is generated using what is called ‘deductive reasoning’.

In mathematics this is something like saying, “If A = B and B = C, then A = C.” In common parlance, it is like saying, “All apples are fruits, all fruits grow on trees; therefore, all apples grow on trees.” In more intricate cases, each step of a proof has to lead to the next one in a logical manner, till you reach a conclusion. You can make your own examples of deductive reasoning. We do it everyday, though we do not always recognise it. Sounds pretty straightforward, doesn’t it? But it needn’t always be the case. For some theorems, the proofs can run into hundreds of pages, like the proof of what is famously known as ‘Fermat’s Last Theorem’, which is nearly 129 pages long! It was called the ‘proof of the twentieth century’. More on that later.

For me, this was a new way of doing mathematics, used as we were till then to mainly doing calculations of various kinds. This was a new kind of animal that had to be understood. It wasn’t easy. But it was an important step we were taking in establishing truth or falsehood in mathematics.

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