

# What We Steal When We Teach

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**“The scandal of education is that every time you teach something, you deprive a child of the pleasure and benefit of discovery.”**

– Seymour Papert, *The Children's Machine* (1993)

About 95 years ago, a two-year-old was obsessed with automobiles. He loved cars so much that he could name all the parts of the car. Over time, he understood how gears work, and then became so deeply involved with gears that they became one of his favourite toys. He liked rotating circular objects such as bottle caps against each other. It was fascinating to see how turning one of the gears in one direction rotated the other gear in a different direction. That was his first interaction with, and understanding of, chains of cause and effect.



Figure 1: Source: <https://bit.ly/4ovZAA0>

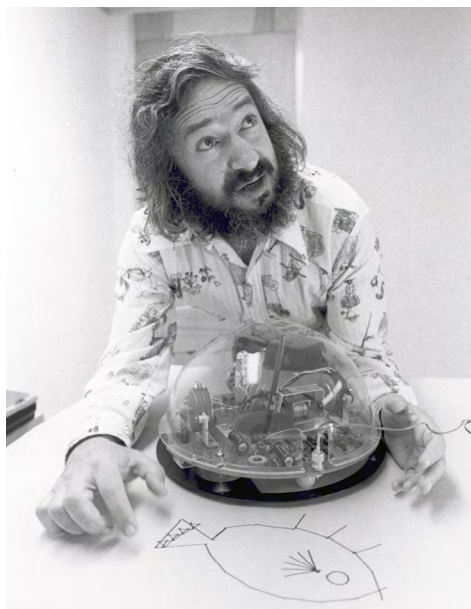


Figure 2: Source: <https://bit.ly/43yokzx>

That man, that legend - that history fondly remembers was a very special person. He was Seymour Papert. He believed that if he described his play with most educationalists, they'd recommend that he create a gear set which children could use to learn about gears. But the essence of his story, was that he loved gears. That is why he could play endlessly with them. He liked rotating gears - and saw the manual that came with such a gear set as an interference.

After consistently working on his ideas on pedagogy, he reached a point where he concluded that while a gear set without a rigid set of instructions might not be able to promote exploration and discovery, perhaps computers could play this role. He developed the game LOGO (see [2]) and developed it to fill what he felt was the need of the hour.

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I had never heard of Papert until I came across his book *Mindstorms* [1], a while ago. In *Mindstorms*, he mentions his interaction with gears in the preface. From there, he argues that computers and programming can serve a similar role for children, creating environments where mathematical ideas feel natural rather than imposed. His central belief is that learning is not about consuming knowledge but about living within an environment that supports it. Just as a child growing up in England learns fluent English simply by being immersed in an English-speaking environment, while the same child might struggle with conversing in English in India. Papert suggests that schools can use computers to build mathematical “environments” where young kids construct knowledge naturally, through exploration and visual programming, rather than treating mathematics as an alien and difficult subject.

### Democracy within the Classroom

Now, shedding some light on my recent endeavours of volunteering to teach English at a local Odia Medium Primary School. All of the class environment restructuring that I will speak of in this segment, might not have any direct connection with mathematics learning, but then, neither did Papert’s gears. The idea, for me, is to establish the kind of environment I wanted the classroom to shape into. A classroom where knowledge and learning were constructed by them and they felt a sense of ownership over their learning. We would only provide prompts where necessary, to scaffold their learning. This keeps the students excited and engaged. Their brains are consistently made to think unconventionally rather than memorize information and write answers. Many students develop a fear of mathematics even before engaging with it, as their environment repeatedly reinforces the belief that the subject is inherently difficult and intimidating and that there is only one correct process which would lead to one correct answer. So, it felt more natural to first get them to think and talk rather than throwing problems in mathematics at them.

Inspired by Robin Williams’ Mr. Keatings from the movie *Dead Poets Society*, I was determined to build a classroom that learnt to think and feel deeply and seize every day. In Class 5, I decided to build a class reflecting democracy. First, we formed a cabinet of ministers. Pragyan was Chief Minister, Ipsita the Reading Minister. When students hesitated to read aloud, they divided the class into two groups and led their peers. The room turned noisy but joyful, full of reading and peer support. Later, we expanded into a Legislative Body: Class 5 as Lok Sabha, Class 4 as Rajya Sabha, with teachers as presiding officers. A debate on whether cinema was good or bad ended with a unanimous vote in favour of films as a source of knowledge and exposure. A detailed account of the results we observed during these proceedings is a little beyond the scope of this article which shall primarily focus on the mathematical experiences.

### The Problem of the Day

Two young students named Sai Nigam and Swagat, who loved mathematics a lot were appointed as the Problem of the Day Ministers. Their job was to write one interesting problem a day on an unused blackboard of the school. Other students could read and solve these during the school hours. It was decided that the solution of the problem would be discussed at the end of school hours every day.

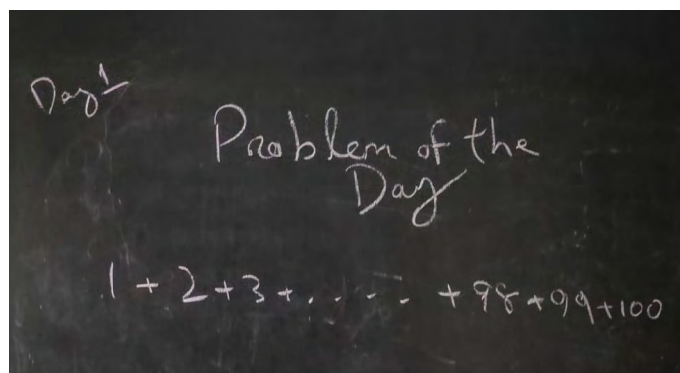


Figure 3

The two ‘ministers’ were provided with an Odia book named “Dinaku Khandie Anka (One Problem a Day)” authored by Prof. Chandra Kishore Mahapatra who in his prime was an active Olympiad Trainer in Odisha. The book had a very interesting structure. There were 12 chapters each representing a month, and each chapter consisted of 30 or 31 or 28 questions depending on the month after which the chapter was named. The solutions to all the questions, which were comprehensible with self-study, were placed after the problems chapters. But I had made it clear that we should try a question for at least 30 minutes to 1 hour before we decide to look into the solutions. An important consideration by me for selecting the specific students for the Problem of the Day Minister role was based on their honesty and sincerity. The first problem that was written on the board on July 23, 2025 was the famous  $1 + 2 + 3 + 4 + \dots + 97 + 98 + 99 + 100 = ?$  which was taken from the cover of another book by Prof C.K. Mahapatra.

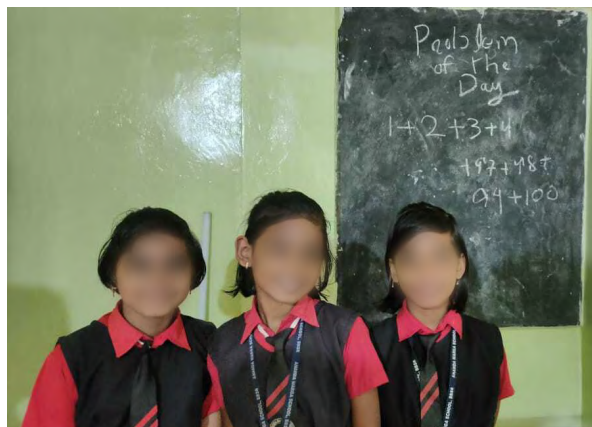


Figure 4

Now a majority of the students ruled out the possibility of this question being solved. But three students named Sai Sampurna, Pragyan and Ipsita were actively working on the question. More importantly they were working on it together. Exactly the kind of collaboration that I had been hoping would be a consequence of the Democratic classroom design. Even during the recess, I could see them solving it.

$$1 + 2 = 3$$

$$3 + 3 = 6$$

$$6 + 4 = 10$$

$$10 + 5 = 15$$

And so on until they just got confused and ended up adding a number twice or just getting the wrong sum and feeling the need to start over again. Even the other teachers of the school saw them attempt this question repeatedly. About an hour later, when I was teaching in Class 4, these three students came up with the answer 5050 and more importantly the solution written on a page which has been replicated in Figure 5 for the benefit of the reader.

One can clearly see the effort and the structure in approaching this problem that these three students took to reach the solution. Are they as good as Carl Friedrich Gauss who devised a very popular solution to this question during his school years? Well, no, at least not yet. But are they better than students who waited to be taught a method or were taught the Gauss Method without even taking a chance to solve this question by themselves? I believe yes.

	3	6	10	15	21	28	36	45	55
1	2	3	4	5	6	7	8	9	10
66	78	91	105	120	136	153	171	190	210
11	12	13	14	15	16	17	18	19	20
231	253	276	300	325	351	378	406	435	465
21	22	23	24	25	26	27	28	29	30
496	528	561	595	630	666	703	741	780	820
31	32	33	34	35	36	37	38	39	40
861	903	946	990	1035	1081	1128	1176	1225	1275
41	42	43	44	45	46	47	48	49	50
1326	1378	1431	1485	1540	1596	1653	1711	1770	1830
51	52	53	54	55	56	57	58	59	60
1891	1953	2016	2080	2145	2211	2278	2346	2415	2485
61	62	63	64	65	66	67	68	69	70
2556	2628	2701	2775	2850	2926	3003	3081	3160	3240
71	72	73	74	75	76	77	78	79	80
3321	3403	3486	3570	3655	3741	3828	3916	4005	4095
81	82	83	84	85	86	87	88	89	90
4186	4278	4371	4465	4560	4656	4753	4851	4950	5050
91	92	93	94	95	96	97	98	99	100

Figure 5



Figure 6

Of course, I told them and the others in the classroom the story of Gauss and his teacher after that and one can imagine how exciting it must've been for some students, who for the last hour were only interested in solving the question. When I showed them the picture of Gauss, I'm sure that was the first time they saw a foreign mathematician/scientist who wasn't Einstein; I'm sure it was the first time they heard a story around mathematics, that too a real one. After this, I also showed them a

YouTube video of the Art of Problem Solving where Richard Rusczyk was solving this very question in a 2:49 minutes timed video. We all proceeded to discover a playlist of 151 Prealgebra videos [6] in the same YouTube channel by going through the recommendations.

A Problem of the Day ritual followed in a classroom can set a lovely atmosphere of mathematical thinking. These problems can be of a wide variety and can be taken from age-appropriate mathematics contests from around the world. (I've put the link to some such contests in the references.) It helps to give problems where they can take their time and figure out various ways of solving it. For example, in a problem like the one shown in Figure 7, one could simply solve this question if they notice that the number of 1s and 0s in each column is the same and is equal to 2. But on the other hand, a group of students might simply sit down and make an entire diagram of the fixtures, which can be a really creative outcome. It also helps you follow up the momentum by designing questions made on fixtures and tournaments. The kind of problems that we need to avoid are problems which are too difficult, because that will have them lose both interest and confidence. If they continue solving these non-routine easy problems, it's only a matter of time before they learn to figure out difficult problems, which generally are a culmination of two or more simple problem-solving thoughts.

**Lola, Lolo, Tiya, and Tiyo participated in a ping pong tournament. Each player competed against each of the other three players exactly twice. Shown below are the win-loss records for the players. The numbers 1 and 0 represent a win or loss, respectively. For example, Lola won five matches and lost the fourth match. What was Tiyo's win-loss record?**

Player	Result
Lola	111011
Lolo	101010
Tiya	010100
Tiyo	??????

A) 000101      B) 001001      C) 010000      D) 010101      E) 011000

Figure 7: 2023 AMC 8 Problems/Problem 8

Having said that, it is preferable to take problems that can expand into some kind of pattern, or a problem that has more than one answer. For instance, ask them to add the first  $n$  consecutive odd numbers, giving them the question for very small values of  $n$ . Encourage them to look for patterns in the answer. When they realise that all the sums are square numbers, slowly guide them, by using Chess Board with pieces or Four in a Row Board or any such game which you find available. It will

take them time, but with some hints, they'd remember the experience of figuring out the geometric representation lifelong. These kinds of problems are available in plenty. For starters, one can find such problems in the Pull-Out section of *At Right Angles*, March 2025 issue, a highly enriching article named Patterns and Pre-Algebra by Padmapriya Shirali.

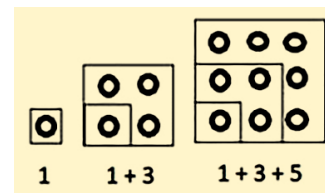


Figure 8

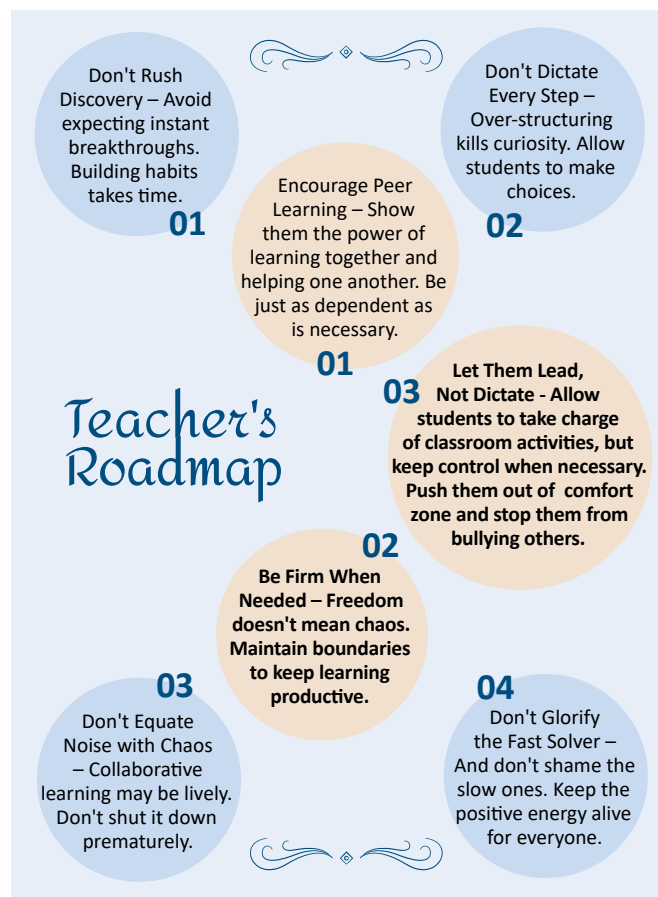


Figure 9

### Final Advice

Discovery-based learning proceeds slowly initially but can accelerate exponentially. Even the anecdote I've shared about the problem came after over a month of classes in April vacation and a few days after school reopened post the summer break where we were focusing entirely on Language and Social Studies to build their thought process before diving into mathematics. The goal is to help students learn how to learn: how to navigate the internet, follow meaningful YouTube playlists, and take notes from videos. By the time they're in Class 8, who knows, they might bring you a write-up they want to submit to a mathematics magazine like *At Right Angles*. After all, in the very words of Seymour Papert:

**"The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge."**

That happened to me. My father, a physicist himself, encouraged me to explore the internet thoughtfully, told me stories from Sherlock Holmes and watched cinema of the likes of Bicycle Thieves with me. With time, I found myself writing short detective stories around cryptography and codes and submitting them to magazines like Stone Soup. I never got published, but looking back it's among the very innocent and enriching memories I have. The real task is to take children seriously, not as passive learners but as active builders of their own knowledge. The greater task is not just to teach but to slowly teach them how to teach themselves.

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## ↔ A Call for Participation ↔

Mathematics, by nature, is cumulative and hierarchical. Therefore, from a teacher's perspective, it is important to ensure each time that the learners have no gaps in their prerequisite knowledge. In some cases, this may require recall or revision of concepts taught in previous grades. We, at At Right Angles, are conceiving the idea of bringing out articles that discuss strategies employed by teachers in introducing new topics. We will keep in mind the prerequisites, as well as, certain challenges they may have faced when prerequisites are not achieved by a significant proportion of the class. We will also discuss how they could navigate through such challenges.

For instance, the topic 'Fractions' is now introduced in grade 3 and continues in grades 4 and 5. One can identify the following prerequisites for the chapter on fractions in grade 3:

- **Broadly** - number sense, operations of addition and multiplication by 2 on natural numbers
- **Broadly** - intuitive sense of area - comparing them to conclude which is more, which is less, which are equal
- **Specifically** - comparing natural numbers (at least smaller numbers)

The teacher has to notice the prerequisites in terms of concepts, skills, thinking (multiplicative thinking/additive thinking), computations, and sometimes intuitive understanding needed for a topic.



We request our readers, particularly teachers engaging students of grades 3, 4 and 5 to take time in filling out the form (QR code & link provided <https://bit.ly/49dSbkn>) to help us understand how one has gone about these processes during the planning for and teaching of new topics.