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your

PROBLEM SOLVING SPEED

**Boards/ JEE/ NEET
& all Comp. Exam**

Chapter Name	Page No.
1. How to Sharpen Problem Solving Skills?	1
2. Toppers Approach to Problem Solving	2
3. While practicing, try solving questions completely	6
4. What is a misconception?	10
5. How to Develop critical thinking ability and the ability to think out of the box?	15
6. Strategies to develop critical thinking ability	17
7. Summary	19

01

How to Sharpen Problem Solving Skills?

In a competitive exam it is not important whether you know the question or not or whether you can solve the question or not but what is important is whether you can solve the question in the shortest possible time or not. The goal of this chapter is to teach problem solving approaches so that you can become an expert problem solver. Effective, expert problem solving involves answering six questions:

- **What's the problem about?**
- **What am I asked to find?**
- **What information am I to use? What principles apply?**
- **What do I know about similar situations?**
- **How can I go about applying the information to solve the problem?**
- **Does my solution make sense?**



As a student you will decide, “is this an energy problem,” or, “is this a Newton second law problem.” A novice is more likely to decide, “is this a pulley problem,” or, “is this a baseball problem.” The novice concentrates on the surface features of the problem while an expert concentrates on the underlying principle. An expert problem solver, will answer the above questions, play around (briefly) with the problem, and make drawings and sketches (either in your mind or on paper) before writing down formulas and plugging in numbers. A novice problem solver, on the other hand, will try to write down equations

and plug in numbers as soon as possible. So the key issue is -

“How to become an expert problem solver?”

02

Toppers Approach to Problem Solving



There's a story of a very strong and skilled woodcutter who asked for a job with a timber merchant. He got the job with a good salary and decent work conditions. So, the woodcutter was determined to do his best for the boss. His boss gave him an axe and on his first day, the woodcutter chopped down 15 trees. The boss was pleased and said, "Well done, good work!" Highly motivated, the woodcutter tried harder the next day, but he only could bring down 13 trees. The third day, he tried

even harder, but he was only able to bring down 11 trees. Day after day, he tried harder but cut down a smaller number of trees.

"I must be losing my strength," the woodcutter thought. He apologised to the boss, claiming he could not understand the reason for his unproductivity. "When was the last time you have sharpened your axe?" the boss asked.

"Sharpen? I had no time to sharpen my axe. I have been too busy cutting down trees." He then decided to sharpen his axe immediately and was back to chopping down 15 trees a day. Since then, he begins the day by sharpening his axe.

Most students are too busy studying and trying to excel in academics and other competitive

exams but they do not have the time or patience to update their study skills or approach. They fail to understand that if you're overworking yourself and your productivity drops, you need to take a break. Take time to think and reflect where you are going wrong and then work towards it. Stop assuming that you've the best approach yet you're unavailable to yield the desired result. The woodcutter only becomes more productive by sharpening his blade, analysing new woodcutting techniques, exercising to become stronger, and learning from other woodcutters. Similarly, you have to sharpen your skill, analyse new study techniques and learn from people around. Stretch yourself (mentally and physically), sharpen your critical thinking through interaction, and identify your blind spots (understand, acknowledge and address them). Get out of your comfort zone to bring a change in the approach and increase your personal production capacity by daily self-maintenance and introspection.

After interacting with a lot of students I observed that most of us do not have the correct approach towards problem solving. Some of

the common made mistakes are:

- Many students read the question and the solution and then satisfy themselves that they could have attempted the question in a similar manner.
- Many students lay too much emphasis on solving a higher number of questions.

Remember that there is no dearth of books and problems available. One has to draw boundaries and concentrate on quality rather than quantity. Doing 100 quality and concept based questions is more important than doing 1000 questions which have not been selected carefully. The purpose is to sharpen problem-solving skills. It is possible to prepare a topic by doing 30-40 problems but only if you try to solve them completely by yourself. This may also involve devoting half an hour or one hour or may be even more on an occasional problem. On the other hand, your preparation can be very weak and hollow even if you have attempted more than 200 problems on the same topic in the same time, thereby devoting much less time on difficult problems and leaving them as doubts to

be cleared from your teachers. The key to success in sharpening problem solving skills is to practice quality questions without seeing the solution.

In fact, it should be noted that Problem solving is the end result of many other important activities like

problems successfully. Another misconception is collecting problems from all sources and then trying to solve them. Plan beforehand and tell yourself that you will solve a particular number of problems in the topic. Once you have achieved proficiency you need not waste your time in collecting still more problems. Also important here is that we have to solve relevant problems, problems of the level that are asked in the exams. Solving problems from here and there can lead to frustration which can disturb the entire plan. Let us now discuss each of the above key steps involved in problem solving.



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STEP I: Proper understanding of concept and its application.

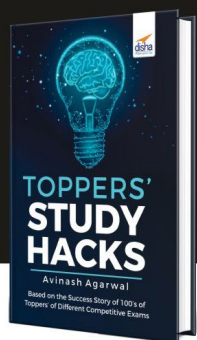
STEP II: Mastering skills such as visualization

STEP III: Continuous interaction between theory and problems.

If you have done all these activities properly, only then you would be able to solve

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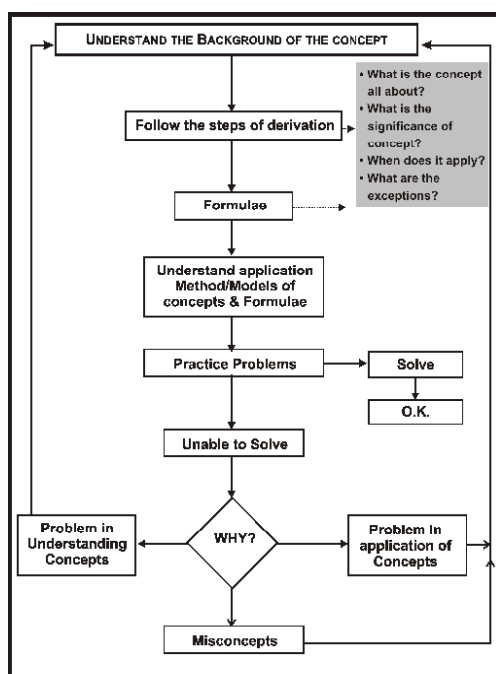
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STEP I: Proper understanding of Concept and its Application

It has been seen that normally students move directly to the formulae and start solving problems. The result, after solving a few problems they get stuck and ultimately get frustrated. This is basically because of the wrong approach towards the subject. It is advised that students should follow the following steps in order to have proper understanding of concepts and their applications.

Basic steps of learning any concept

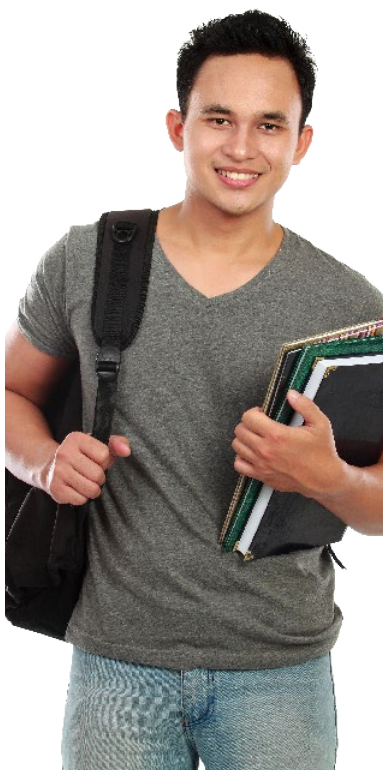


- Understand the background of the concept
 - What is the concept all about?
 - What does the concept say?
 - Focus on significance of the concept
 - What are the exceptions to this concept?
 - When, Where and How to apply this concept?
- Follow the steps of derivation of the concept
- TRY TO REPRODUCE CONCEPT IN YOUR WORDS

- In case of any doubt read and understand the concept again
- Understand the application method of the concept
- Practice questions on the concept (Start from the easy and gradually move to the difficult ones)
- Diagnose the problems and take corrective measures

03

While practicing, try solving questions completely



After mastering the concept and application methods, try to solve the question on your own. Try solving questions completely until you achieve mastery of the application method and concept. Write every step of the application method and solve the question.

Remember that trying shortcuts or solving questions in a brief manner in the beginning itself will lead to serious problems and you will not be able to gain mastery.

Let me elucidate my point with a short and interesting story.



A salt seller used to carry the salt bag on his donkey to the market every day. On the way they had to cross a stream. One day the donkey suddenly tumbled down the stream and the salt bag also fell into the water. The salt dissolved in the water and hence the bag became very light to carry. The donkey was happy. Then the donkey started to play the same trick every day. The salt seller came to understand the trick and decided to teach a lesson to it. The next day he loaded a cotton bag on the donkey. Again, it played the same trick hoping that the cotton bag would become lighter. But the dampened cotton became very heavy to carry and the donkey suffered. It learnt a lesson. It didn't play the trick anymore after that day, and the seller was happy.

Most of the students are always looking for shortcuts. They never follow the steps of derivation and directly move to formulae and start solving the questions.

Also, when they get stuck instead of trying on their own they refer to the solutions. Sometimes shortcuts work and luck favours you but that cannot always work. Luck might favour you once or twice but what counts at the end of the day are your passion, hard work, creativity, smartness and patience. *You need to have a proper strategy without cheating and cover up everything so that no matter how twisted or difficult the question paper appears, you are able to get through.*

Remember what Dr A.P.J Abdul Kalam said – “Don't take rest after your first victory because if you fail in second, more lips are waiting to say that your first victory was just luck.”

STEP II: Visualization of the Problem

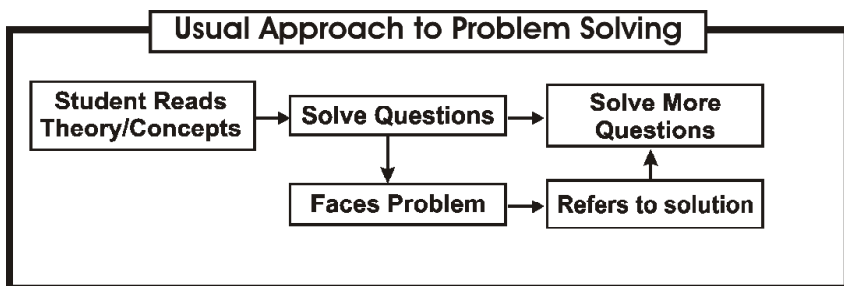
Follow the following steps to convert the problem in the form of a diagram. Conversion of a problem in the form of a diagram helps in better understanding of the concept. Visualisation of a problem involves following steps -

Step 1. Draw the diagram as per the problem.

- Step 2.** Once the diagram is drawn, check the problem again to see if what is asked in the question is clearly represented in the diagram.
- Step 3.** Check if the diagram makes sense. If the diagram looks absurd, there is some problem in your understanding of the question.
- Step 4.** Understand the question now by going through the diagram. If you find that this is not possible, then your representation is wrong. You should be able to explain what is required by interpreting the diagram.
- Step 5.** Make modifications in the diagram till you are clear that the diagram is the exact representation of the problem.
- Step 6.** Do not proceed to the next step till you are confident about the diagram.

STEP III: Interplay Between Theory & Problem Solving

Normally students read the theory, understand the concept and then they keep on solving more and more questions. So the approach followed can be shown by the following diagram.



This is a wrong approach. Ideally, the student should move to & fro between text & questions. Remember, reading the text and solving homework problems is a cycle - questions lead to answers and that lead back to more questions. It is recommended that students should solve questions in rounds and in multiple sittings.

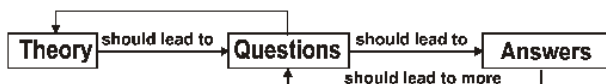
Correct Approach to Problem Solving

Student should move to and fro between theory & questions and so ideally learning should be interplay between

1. Reading / Understanding Concepts

2. Problem Solving

So, understanding the concepts & Problem solving is a Cycle, Questions lead to answers that lead back to more questions



We have already learned that learning always happens in jumps. So rather than trying to complete the entire exercise at one go it is recommended that students should attempt exercises in multiple sittings. The aim of sittings should be

First Round Objective : You should be able to solve 60 to 70% questions

Second Round Objective : You should be able to solve 70 to 80% questions

Third Round Objective : You should be able to solve 90% and above.

Remember, you will learn more in six 1 hour periods spaced through the week than in one 6 hour period.



04

What is a Misconcept?



How to identify and remove Misconcepts ?

The normal sequence of steps followed by student in problem solving are :

1. The student solves a problem
2. The student checks up the answer
3. The student finds that the answer is wrong
4. The student reviews the solution
5. Sometimes they find that they have made a simple mistake which when corrected gives
6. A far more dangerous possibility is that after verification also the solution seems to be correct.

the correct answer. This is a very good state of affairs and the student need not be worried if most of the time they face such a situation. However if they make such silly mistakes too often it is a cause of worry. They should then figure out reasons why they make such mistakes and remove these causes.

6. A far more dangerous possibility is that after verification also the solution seems to be correct.

This is the Stage of Misconception.

At this stage, the student is confused. They either -

- Try to find some way of getting the solution right by trying out alternate methods or by hit and trial approach, or
- Ignore their method and understand the solution.

Both of them are not the correct way to approach the problems. Ideally, what a student should do is to critically analyse his approach to the solution and try to find out where did he go wrong and what is the corrective measure he should take so as to avoid these kinds of mistakes in the future. It is very important to find out the misconception and initiate steps to remove the misconcepts.

What should I do if I am not able to solve a question?

Don't get demotivated at any point of time if you aren't able to solve a problem, rather take it as a challenge, struggle and think like if you solve it you'll be able to learn something new. Let me clarify my point with an interesting story.



Once upon a time, a man found a butterfly that was starting to hatch from its cocoon. He sat down and watched the butterfly for hours as it struggled to force itself through a tiny hole. Then, it suddenly stopped making progress and looked like it was stuck. The man then decided to help the butterfly out. He took a pair of scissors and cut off the remaining bit of the cocoon. The butterfly then emerged easily, although it had a swollen body and small, shriveled wings. The man thought nothing of it, and he sat there waiting for the wings to enlarge to support the butterfly. However, that never happened. The butterfly spent the rest of its life unable to fly, crawling around with small wings and a swollen body.

Despite the man's kind heart, he didn't understand that the restricting cocoon and the struggle

needed by the butterfly to get itself through the small hole were God's way of forcing fluid from the body of the butterfly into its wings to prepare itself for flying once it was free."

The example of the butterfly highlights the importance of struggle in life. You have no other option but to struggle to reach your goal. Some students when stuck with a problem solving, immediately check the solution mentioned towards the end of the chapter/book because they are not willing to work hard. So what happens is such students get stuck in the same question again when they are to solve it later. While **there are a few other students who struggle with difficult questions for hours. In the process they develop their problem solving skills and take their preparation to the next level.** Such struggle is helpful for brain growth and is important if you are to achieve something. If you are not struggling, you are not learning.

I will suggest you a simple and effective approach to solve questions without seeing the solution



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Step 1: Approach an exercise only when you have thoroughly mastered the fundamentals

If you are unable to solve a problem at first attempt, come back to that question after some time, say half an hour or an hour. While making the second attempt start on a fresh page. Try to think independently of the first attempt and never get driven by the approach in the first attempt.

Step 2: If you are not able to solve the problem even in the second attempt then the next step is to identify the basic concept involved in the question. For e.g. if the basic concept is $E = MC^2$



Step 3: The next step is to open your Physics Book. Open that unit, that chapter and that page where this concept is being discussed. Read that page with half the pace with which you normally read Physics. So study the relevant theory again, paying attention to the finer points and keeping the problem in mind. **Research shows that if a student follows this method seriously then there is a 70 % chance that he would be able to solve the problem. It also sharpens his problem solving skills.**

Step 4: If you are not able to solve the question even by step 3 then the last step would be to consult the teacher or refer to the solution. But here also the key is not only to understand the solution but also to find out what were the clues/steps/tricks you missed because of which you could not solve the question. So the idea is to analyze the problem threadbare so as to find out the steps you missed and then practicing more similar kinds of problems so that you can master the tricks involved.

Practice this problem solving approach for some time and continue if you find it useful. Another frequently asked question by students is -

“How can we develop our own shortcuts & tricks?”

I will answer this question with the help of an incident which happened in my student life.

One day in Maths class our teacher asked -



“What is the sum of the first hundred digits?”

At that point of time we were not told the formulae

$$\frac{n(n+1)}{2}$$

Most of the students started writing the numbers.

While all of us were writing the numbers, one of my friends immediately raised his hand and on being asked the answer, he answered 5050. We all were surprised by his quick response. When we asked him what method he adopted to calculate it so fast, he said take one digit from beginning and one from end i.e. $1 + 99 = 100$, $2 + 98$

= 100. Similarly, you can make 49 pairs of 100 so that makes it 4900 +100+50 = 5050

Few years later that friend of mine cleared JEE with an AIR of 6

That is thinking out of the box. The message is to think in a non-conventional manner. What is important is what comes to your mind when you see the problem, how and in what direction you attack it. Remember this is the only way to develop your own shortcuts for solving problems. So, do not give up solving a problem after one or two attempts and always remember that it is only by practicing problems that you can improve your analytical skills.

Relax and don't get tense as this kind of thinking power does not develop overnight. It is developed gradually and for it to happen you

have to be patient in the initial stages and keep on thinking diversely even if that is of no use.

So while solving a problem, try to strengthen and develop your conceptual understanding by analyzing deeply and correlating the problem with real life situations and look at the solution only after you have given it your best shot. It is my conviction that more than one half of the learning that you do in any subject is a result of working on the problems. You must develop enough discipline to try and work each exercise without looking at the solution. Start with conventional methods of problem solving. Then improvise constantly and build your own shortcuts & ways of attacking a problem. **Remember the process of learning new things can be an exciting adventure.**



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How to Develop critical Thinking Ability and the Ability to Think Out of the Box?

Critical thinking is one of the most desired skills, especially in competitive exams. You must have often heard people saying that you need to think out of the box to succeed. But what exactly is this thinking out of the box? Well, **thinking out of the box means coming up with ideas that are unique.** With the arising competition in the competitive exam, it is imperative that one develops an out-of-the-box thinking. Let us understand “Critical thinking ability” or “the ability to think out of the box” with the help of a short story.

In a small town, there lived a poor farmer with his beautiful daughter. In the same town lived an old merchant. He was known for his shrewdness and had a dishonest way of dealing with business. Once, the poor farmer finding no options had borrowed a considerable sum of money from the old merchant. The interest was very high. Years passed, and the poor farmer was not able to clear the debt. His evil eyes were on the beauty of the farmer's daughter. Grabbing this opportunity, he played a bet on the poor farmer and the daughter.



There was a mix of white and black pebbles on the ground. The bet was in case he picked the white pebble he would waive off the debt and leave the marriage proposal, and in case he picked the black pebbles he would waive off the debt, but would marry the daughter. The merchant intention was to marry the farmer's daughter so he bent down and intentionally picked both black pebbles, but the daughter noticed it. When the merchant asked the daughter to choose between two hands, the daughter picked one and intentionally dropped the pebble down

and said:

"I am sorry. I could not see the colour of the pebble. So show the pebble on the other hand."

The merchant showed the pebble he had. It was black since he held black pebbles in both the hands. Hence, the dropped pebble would logically be white. In this way the daughter was able to save both herself and her father. The old merchant lost the bet. The debt was cancelled, the daughter and the poor farmer left happily.

The story highlights the fact that you have to think smartly in situations that appear difficult. Similarly, **competitive exams are not about routine thinking. Success in competitive exam is about the ability to think both critically and out of the box in front of new situation.** Such exams are designed to analyse your critical thinking skills. So, when a question looks difficult, put your undivided attention to every detail of the problem. Keep your eyes open, try to be smart and think outside the routine ideas and there you go!



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As Albert Einstein once said, "Creativity is seeing what everyone else has seen, and thinking what no one else has thought." Remember **success in competitive exams is about the ability to think critically and creatively in front of new situations.**

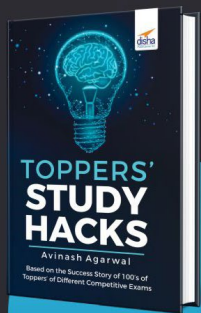
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Strategies to develop Critical Thinking Ability

- **Note down your questions and ideas**

Whenever you have an idea or a question in your mind while reading, make sure you write it down somewhere. A lot of times we come up with a new question or idea and assume that we will remember it. However, that does not always happen and a good point is lost because of negligence.

- **Ask open-ended questions**

Asking open-ended questions help students to think outside the box. Many times during the school days, students keep responding to closed questions. The thinking involved in this is quite minimal and there is only one possible correct answer.

- **Establish discussion routines**

Student-centred classroom discussions give students ample opportunities to think outside the box. If students are involved in regular discussions with teachers and tutors about topics taught in the class or coaching, it prompts the higher-order



thinking skills of the students. As students become accustomed to such prompts as a routine part of class discussions, it creates more space for creative thinking.

- **Find connection**

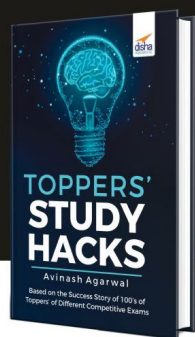
Re-organize the material into categories or groupings, by asking, “How do these things fit together? What elements are related and how are they relative? What general groupings are there?” You will be surprised to know interconnected various topics are. If you want to enhance your ideation process, read carefully. This way you will be able to come up with ideas that are unique. Mind maps can help you to find connections.

- **Start from the beginning**

Just as in chess, you sometimes take a few steps back to take a leap forward. This is similar in terms of studies. If you feel like that you are unable to think and come up with effective ideas, it's best to start fresh. A small nap or a little entertainment can do some great wonders to help you out with a new and better perspective.

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There are no tricks or short-cuts when it comes to succeeding in your studies. Remember, there is no substitute for hard work. But what is meant by “hard work”? One component is time spent on tasks. When we speak of time, we should consider both the quantity of time spent and the quality of time spent.

There is so much material to be understood that a substantial time commitment is required. There is time spent in classes, but also time spent preparing for class, reading the assigned pages, upgrading notes, and studying for tests. Yet, a student can devote a lot of time to these activities and still do poorly. This is because the quality of time spent is also an important factor. Many students become discouraged when, though they spend hours and even days studying for tests, they still get unsatisfactory scores. Usually this occurs because what they do when they study is low-quality work.

What are some examples of low-quality work? One example would be reading the textbook just to complete the assignment. A student who reads properly, on the other hand, reads with a critical eye, constantly asking himself/herself questions such as, “If I had to teach this to someone, could I do it?” or “What if this process were screwed up somehow; then how would the results differ?” or “The text’s treatment of this topic differs from what I learned in high school (or what I learned in class today); what question could I ask in class that might clear this up?”

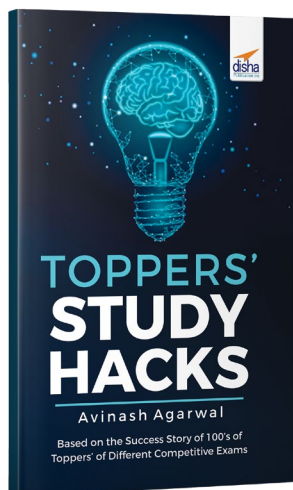
Another example of low-quality work is going over and over your class

notes. This is an activity that assumes one will be tested in a low-quality fashion, i.e. with test items that require you to do nothing but recall and repeat. This is a false assumption. You will be asked to integrate concepts from different lectures, to apply the principles covered in class to situations that were not covered in the lecture or text, to evaluate new situations in light of the material covered during the test unit. High-quality work entails preparing for such questions. Preparing entails organizing the mass of new information in such a way that it helps you understand the way the concepts are related to each other.

A final example of low-quality work is coming to class regularly and just taking notes. Why is this low-quality work? Because many students become passive when they take notes. They switch off their brains and assume that they will understand everything after the class. As in other things, your attendance at lectures can be either low-quality or high-quality. High-quality attendance entails being critical during the lecture, asking questions like: “Why does it work that way?” or “How do we know that? What is the evidence?” “How does that relate to what the professor said the other day about...?” There is a world of difference between questions such as those listed above and questions like: “Could you repeat that?” or “Could you spell that?” or “Do we have to know this for the test?” The answers to these questions might be important, but asking them does not indicate that critical thinking has been going on, as do the earlier questions.

As you can see, the successful student will necessarily have to work hard. **The suggestions above are labor-intensive; they require more mental gymnastics. But just as a gymnast would be foolish to expect to succeed at a complex maneuver on the first try at an important competition, as foolish would be a student who expected to pass tests requiring higher-order thought processes without first practicing the basic principles.**

About the Author



Mr Avinash Agarwal is a seasoned counsellor in the field of academics and life skills. He is a B-Tech in Computer Science followed by MBA from MDI, Gurgaon. Densely exposed to students, teachers and administrators in India as well as abroad, he has worked diligently for the transformation of classroom teaching. He is on a mission to empower millions of students by helping them reach their full potential and excel not only in exams but also in life. In the last 15 years, he has taken hundreds of seminars and workshops touching the lives of lakhs of teachers and students. His recent book on teacher empowerment, "I am a teacher" is an exemplar of that. Besides being a study coach, he is also a travel enthusiast and an avid sportsman..



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