

**Metacognitive Skills (Overview)**  
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**Text studying**

**Problem solving**

<p><i>Orientation/task analysis</i></p> <ul style="list-style-type: none"> <li>- Thoroughly and completely reading the assignment. (<i>Why</i>: the assignment tell you what you have to do; you need to understand why and how to read the text.)</li> <li>- Determine from the assignment (or learning context) why you have to read the text =&gt; 1<sup>st</sup> global goal setting: what is expected from you as reader? (<i>Why</i>: knowing beforehand what is expected from you, helps you to read the text in a focused way from the start =&gt; results in less re-reading, less time.)</li> <li>- Reading the head or title (to find the topic of the text). (<i>Why</i>: the title often contains the topic of the text =&gt; knowing the topic beforehand facilitates reading.)</li> <li>- Activate prior knowledge about the topic or type of text from memory. (<i>Why</i>: prior knowledge about the topic/type of text supports reading the text; you can retrieve word meanings faster, you will understand relations between concepts faster and better, etc.)</li> <li>- Relating a new chapter to the contents of earlier chapters. (<i>Why</i>: a new chapter often builds on knowledge from earlier chapters; you will need this prior knowledge for reading the new chapter.)</li> <li>- Scanning the text for content, structure, and length =&gt; reading subheadings, looking at pictures. (<i>Why</i>: knowing the structure of the text beforehand substantially facilitates reading the text, because you can anticipate what</li> </ul>	<p><i>Orientation/task analysis</i></p> <ul style="list-style-type: none"> <li>- Thoroughly and completely reading the assignment. (<i>Why</i>: reading the entire text of the problem statement, before doing any calculations/solving the problem, is necessary in order to understand which answer is expected from you, on the basis of which givens in the problem statement.)</li> <li>- Determine what is asked for =&gt; 1<sup>st</sup> global goal setting: what do you need to get to know? (<i>Why</i>: if you know what is asked for, you know what answer is expected from you =&gt; this reduces the risk of an incorrect answer.)</li> <li>- Preliminary selection of relevant/irrelevant or redundant givens. (<i>Why</i>: ignoring irrelevant givens prevents you from heading on the wrong track and from taking unnecessary actions.)</li> <li>- Viewing diagrams, tables, or pictures to extract relevant information. (<i>Why</i>: pictorial info is essential/helpful for understanding and solving the problem; thus, it is foolish to disregard that info.)</li> <li>- Activating prior knowledge from memory about the subject matter or about similar problems you have solved before. (<i>Why</i>: prior knowledge about the topic/type of problems helps you with doing the assignment; You better understand the assignment and you can also find potential ways to solve the problem.)</li> <li>- Making a drawing/schema of the problem (with relevant givens included). (<i>Why</i>: by making a drawing or schema, you can</li> </ul>
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<p>will come next =&gt; less time.)</p> <ul style="list-style-type: none"> <li>- First reading the summary at the beginning or the conclusion at the end of the text in order to get a global impression of the content. (<i>Why</i>: knowing the major idea of a text beforehand facilitates your reading and understanding of the text =&gt; faster &amp; better reading.)</li> <li>- Estimating the level of text difficulty. (<i>Why</i>: helps you to determine the required effort in terms of time, attention, and reading strategies.)</li> <li>- Making predictions about the course of the text (and adjust during reading). (<i>Why</i>: if you know what to expect, you can read and process the text faster and better.)</li> <li>- Formulating your own questions prior to reading the text. (<i>Why</i>: by asking questions beforehand, you draw your attention to relevant parts of the text =&gt; selective reading implies better reading.)</li> <li>- Summarizing of what this orientation on the text has yielded (monitoring orientation phase). (<i>Why</i>: checking whether you sufficiently understand what is expected from you, will prevent you from reading/studying the text in the wrong way.)</li> </ul>	<p>better understand the nature of the problem and look for a potential solution to the problem.)</p> <ul style="list-style-type: none"> <li>- Estimating difficulty and task demands of the assignment. (<i>Why</i>: helps you to determine the required effort in terms of time, attention, and problem-solving strategies.)</li> <li>- Estimation of (plausible or possible) outcomes =&gt; sets the stage for later monitoring and evaluation. (<i>Why</i>: estimations beforehand allow for checking your outcomes afterwards against your estimations =&gt; less unnoticed mistakes.)</li> <li>- Check whether you sufficiently understand the assignment at this point (monitoring orientation phase). (<i>Why</i>: knowing that you are on the right track, before starting to calculate/solve the problem, reduces time needed to repair mistakes.)</li> </ul>
<p><i>Goal setting</i></p> <ul style="list-style-type: none"> <li>- Formulating an explicit reading goal =&gt; what should you know or be able to do <i>after</i> reading the text. (<i>Why</i>: if you know what information you have to retrieve from the text, you can focus your reading efforts =&gt; better text understanding &amp; better results.)</li> <li>- Discriminating between a study goal and a search goal before reading the text. (<i>Why</i>: a study goals requires you to read and study the entire text, while a search goals requires you to scan</li> </ul>	<p><i>Goal setting</i></p> <ul style="list-style-type: none"> <li>- Formulating a learning goal =&gt; recognition of and knowing how to solve this type of problems (instead of only solving this particular problem). (<i>Why</i>: if you are capable of recognizing the characteristic features of a problem type, then you can more easily solve this type of problems later at the exam.)</li> <li>- Establishing which (prior) knowledge and skills are needed to solve this type of problems (learning to recognize &amp; deal</li> </ul>

the text for specific information; makes a difference in time and effort you need to invest.)

- Establishing what information you will regard as relevant in the text. (*Why*: by establishing beforehand what (kind of) information is important, you can focus your attention => more effective reading and understanding of the text.)
- Testing your reading goal against the assignment text (goal monitoring). (*Why*: before starting to read, you should check whether your reading goal is still in line with the assignment => prevents you from taking the wrong perspective.)

#### *Planning*

- Selective reading: determine the parts of the text you are going to pay attention to (dependent on the reading goal). (*Why*: you cannot devote equal attention to all parts of the text; better take care to focus on the relevant parts of the text, so as to optimally use your reading time=> better outcomes.)
- Determine what you are going to read in which sequence (eg. first roughly reading all paragraphs and then deciding whether to re-read a paragraph more thoroughly; or starting with reading of definitions of concepts and then focusing on the relations between those concepts). (*Why*: a strategic approach in line with your reading goal facilitates information processing during reading => better understanding & results.)
- Determine which less relevant parts of the text you may skip or read superficially. (*Why*: especially under time pressure at exams, you have to selectively read in order to finish the text, but you have to make adequate choices

with task demands). (*Why*: now you can still improve your knowledge and skills, and learn to deal with errors; not at the exam.)

- Testing your goal against the assignment text: checking whether your learning goal fits in with what the assignment expects you to do (goal monitoring). (*Why*: prevents you from investing wasted time and effort in a procedure that does not correspond to the requirements of the assignment.)

#### *Planning*

- Setting sub-goals => dividing a complex problem into partial problems you can handle. (*Why*: organizing a complex problem into manageable parts results in fewer mistakes.)
- Use sub-goals to determine which steps you have to take in order to calculate the outcome (or intermediary outcomes). (*Why*: converts a complex problem into concrete steps that are easy to perform => faster & better solution.)
- Put steps into an orderly sequence through which the outcome of one step can be used in the calculation for the next step. (*Why*: offers maximal control; if you make a mistake, then you can easily retrace your steps to find the mistake you need to repair.)

<p>when doing so.)</p> <p><i>Execution</i></p> <ul style="list-style-type: none"> <li>- Avoid <i>mere</i> linear technical reading =&gt; yields hardly any understanding of the text. (<i>Why</i>: for reading comprehension you need to gain access to the content of the text; it is not sufficient to simply read aloud words and sentences ‘in your mind’.)</li> <li>- Stick to your reading plan, unless the course of the text requires another more adequate plan (monitoring - reorientation - new plan). (<i>Why</i>: your reading plan puts you in control over processing the text =&gt; less mistakes &amp; better comprehension.)</li> <li>- Adapt your speed of reading to the level of text difficulty (also for specific text passages). (<i>Why</i>: when reading a difficult passage too fast, chances are that you miss out relevant ideas =&gt; makes a difference in points awarded.)</li> <li>- Make orderly notes, underline/mark selectively, and draw up schemas of relations between relevant concepts. (<i>Why</i>: these are tools to organize important concepts and their mutual relations =&gt; better text comprehension &amp; better results.)</li> <li>- Reread and paraphrase difficult passages (<i>Why</i>: formulating an idea in your own words requires the proper processing of difficult passages or it allows you to conclude that you do not sufficiently understand a particular idea.)</li> <li>- Make inferences to fill ‘holes in the text’. (<i>Why</i>: relations that are not made explicit in the text, but nevertheless are implicitly assumed, can be used to make your understanding of the text coherent =&gt; better text understanding &amp; better results.)</li> </ul>	<p><i>Execution</i></p> <ul style="list-style-type: none"> <li>- Stick to your step-by-step plan and follow that plan systematically, unless you get stuck (monitoring - reorientation - new plan). (<i>Why</i>: your step-by-step plan puts you in control; when deviating from your planned path without reason, you may get lost and no longer see the wood before the trees.)</li> <li>- Avoid the execution of multiple steps in one mega-operation. (<i>Why</i>: people tend to overestimate their mental capacities, as complex all-in-one operations often result in unnecessary mistakes.)</li> <li>- Make orderly notes of every step (<i>Why</i>: gives an overview of where you have been and where to go; offers the possibility to retrace your steps whenever you have made a mistake.)</li> <li>- Convert units into the right format of a formula (and always report those units in your notes and answer). (<i>Why</i>: careful use of units prevents sloppy mistakes; moreover, not mentioning the right units in your answer often leads to a cut back in points awarded.)</li> </ul>
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- Contrast arguments pro en con & their evidence (also in your notes), weigh them against each other and, finally, draw a conclusion. (*Why*: such contrasts are easy to recollect from memory; they provide a steppingstone for remembering a complex argumentation => better text comprehension & better results.)
- Distinguish major from minor points: first try to grasp the gist or central idea of the text or passage, before you direct your attention to details (depending on your reading goal). (*Why*: readers often tend to lose themselves in details of the text and, consequently, they do not see the wood before the trees.)

#### *Monitoring during execution*

- Check whether you understand words and their meaning. If not, address your lack of understanding => reread definitions, reach for a dictionary, derive meaning from the context, ask for help, etc. (*Why*: if it concerns important words or concepts, then miscomprehension may follow you throughout the text because the conceptual knowledge is assumed in later sentences. Often you can evaluate the importance of a concept only after understanding its meaning. Better text comprehension & better results.)
- Check whether you understand text passages (complex relations, cause & effect, contrasts, etc.). If not, engage in rereading, paging back, temporarily reading ahead and return later, making inferences, etc. (*Why*: if you do not understand relevant text passages, you may get into trouble later on in the text because the knowledge is implicitly assumed. Better text comprehension & better results.)

#### *Monitoring during execution*

- After every step, check whether you made any calculation error or other sloppy mistakes => recalculate, compute backwards from outcome to input values, estimate plausibility of the outcome, check units, etc. (*Why*: if you discover calculational or sloppy errors in time, then repairing the error takes little effort; if you discover the error only at the end, then you have to redo your calculations all over again.)
- Check whether the outcome of one step provides sufficient & correct data for the next step => is the outcome of step A sufficient & relevant for the execution of step B? (*Why*: check for the correct outcome of step A, but also check for the adequacy of your step-by-step plan. More checks and balances => better results.)
- Check whether your steps make progress towards your goal & answer => if not, reorientate - new plan. (*Why*: checking for

<ul style="list-style-type: none"> <li>- Check whether new information is (in-) consistent with your prior knowledge or what you have read before in the text=&gt; this could point at incomprehension on your behalf as reader, or at an erroneous argument of the author. (<i>Why</i>: such a consistency check is a perfect way to test your text comprehension =&gt; better results.)</li> <li>- Check whether you make progress towards your goal: Is the goal adequate? Does your goal fit with the text? Is the information you are looking for available in the text? =&gt; if not, decide to re-orientate and adapt your goal (or to stop reading). (<i>Why</i>: you are at the wheel during reading, but you have to make sure that you stay on the right track. Otherwise, you miss your goal, at the cost of text comprehension &amp; results.)</li> </ul>	<p>progress prevents that you keep on muddling through, without obtaining the required outcome.)</p>
<p><i>Recapitulation</i></p> <ul style="list-style-type: none"> <li>- Make a summary of the text with major concepts, central ideas, and conclusions (in your own words). (<i>Why</i>: Summarizing in your own words is the best way to grasp the gist of the text and to store this information in memory =&gt; better results.)</li> <li>- Look through the text in order to check whether you have included all relevant issues in your summary. (<i>Why</i>: after reading the entire text, some parts of the text that you dismissed as irrelevant, may prove to be relevant in the end =&gt; prevents you from disregarding relevant issues =&gt; better results.)</li> <li>- Review the new insights you have gained from reading the text. (<i>Why</i>: new insights are an important addition to your prior knowledge and, therefore, they should be adequately stored in memory =&gt; better results.)</li> </ul>	<p><i>Recapitulation</i></p> <ul style="list-style-type: none"> <li>- Once you have obtained the outcome, formulate a complete answer (i.e., quantities and units). (<i>Why</i>: a complete answer not only yields more points, it also provides the opportunity to evaluate the answer - see below.)</li> <li>- In your answer, show how you have solved the problem step-by-step (with intermediary products). (<i>Why</i>: this may yield extra points, even when you have made a mistake by accident)</li> <li>- Draw a conclusion, formulated in your own words. (<i>Why</i>: by formulating your conclusion in your words, you can show that you fully understand the problem =&gt; may yield extra points.)</li> </ul>

- Rehearse your summary so as to store it in memory. (*Why*: this will be helpful to you when answering questions about the text => better exam results.)

#### *Evaluation*

- Check whether you have achieved your goal: Do you know enough about the topic of the text? Can you do a test or make an exam about the text? Did you find an answer to your search question? (*Why*: this is a test whether you have adequately processed the text in the light of your reading goal => better results.)
- Reread the assignment in order to check whether you fully complied with the assignment. (*Why*: while reading, you may lose sight on the original assignment. By rereading the assignment in the end, you can check whether you have completed the assignment => better results.)
- If not, reread the text selectively (especially passages, which are difficult or insufficiently understood). (*Why*: enhanced text comprehension => better results.)
- Ask yourself questions about the text to test your knowledge and comprehension. (*Why*: generating questions for the text is a good preparation for the exam.)

#### *Reflection*

- Look back to what went right or wrong during reading or studying the text. (*Why*: from reviewing your efforts, you can learn how to read or study a similar text the next time => facilitates reading in the future.)
- Check whether you had an appropriate expectation of the (course of the) text before starting to read, whether your goal matched

#### *Evaluation*

- Check whether the answer is plausible and approaches your earlier estimation => if not, find out why the answer deviates from your estimation. (*Why*: that is why an earlier estimation is useful as a point of reference to compare your answer with.)
- Check whether you have not made any mistakes by looking through all steps (and recalculating them roughly). (*Why*: this final check on correctness and completeness of all steps may capture and repair potential errors => better results.)
- Check whether your answer really addresses the question in the assignment (by rereading the assignment). (*Why*: while solving the problem, you may have lost sight of the original question in the assignment; by rereading the assignment, you may verify that and resume working on the problem when needed => better results.)

#### *Reflection*

- Look back to what went right or wrong when solving the problem => could you have solved the problem in a better or faster way? (*Why*: from reviewing your problem-solving behavior, you can learn how to solve similar problems the next time => facilitates problem solving in the future.)
- Try to establish what are the

<p>with the assignment &amp; nature of the text, whether you have read the text in the right way (e.g., whether you have paid attention to the right text parts), whether you have sufficiently checked upon your comprehension of the text. (<i>Why</i>: from reviewing your reading behavior, you may learn what to do when reading a similar text in the future =&gt; facilitates future reading.)</p> <ul style="list-style-type: none"> <li>- Try to make explicit what you have learned about what to do when reading the type of texts in the future. (<i>Why</i>: if you deliberately pay attention to what you have learned from reviewing your reading behavior, even for a short while, then chances are that you will more effectively and more efficiently read a text the next time.)</li> </ul>	<p>characteristic givens and questions from which you can recognize this type of problems (keywords, type of question, etc.). (<i>Why</i>: enhances the probability that you can classify a similar assignment accordingly, which facilitates solving problems in the future.)</p> <ul style="list-style-type: none"> <li>- Try to make explicit what you have learned about how to solve this type of problems in the future (e.g.. by memorizing the step-by-step plan roughly). (<i>Why</i>: if you deliberately pay attention to what you have learned from reviewing your problem-solving behavior, even for a short while, then chances are that you will more effectively and more efficiently solve problems the next time.)</li> </ul>
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### Literature sources

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Step-by-step action plan for metacognitive training in problem solving (adapted from Veenman, 2013).

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*Forethought phase:*

- 1) Thoroughly read the entire problem text:
  - 1a) Underline important words in the problem text
  - 1b) Write down what is relevant in the problem text, and what is irrelevant (in a two-column diagram)
- 2) Try to make a drawing of the problem
- 3) Write down in your own words what you need to know (what is asked for)
- 4) Write down what you already know (what is given in the text)
- 5) Do you have a clue about what the outcome roughly would be?
- 6) Set out a plan for how you are going to solve the problem:
  - 6a) Think of which numbers you need to solve the problem
  - 6b) Think of which steps you need to take to solve the problem
  - 6c) Think of which step to take first, and which step next, etc.

*Performance phase:*

- 7) Carry out your plan step-by-step
- 8) Write down everything you do, step-by-step
- 9) In the mean time, monitor yourself to make sure that you are still on the right track:  
Do you still think that you will find the right answer with your plan?
  - 9a) If you think so, continue with your plan
  - 9b) If you do not think so, think of a new plan (go back to step 6)
- 10) If you have found the answer, write down the answer as completely as possible

*Self-reflection phase:*

- 11) Check your calculations:
    - 11a) Does your answer correspond to what you initially thought it should be (in step 5)? If not, check and see whether you have made a calculation mistake by recalculating the problem
    - 11b) Try and calculate the solution in a different way (go back to step 6)
  - 12) Look back to the question: Did you find the answer to that question?
  - 13) If everything tallies, then give the complete answer.
  - 14) Look back to how you solved the problem:
    - 14a) What went well?
    - 14b) What went wrong and why?
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Step-by-step action plan for metacognitive training in text studying (adapted from Veenman, 2013).

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- 1) Thoroughly read the entire assignment to set your reading goal:
    - 1a) To what purpose are you going to read the text?
    - 1b) After reading, are you expected to answer multiple-choice or open-ended questions on a test, to given a presentation, or to write a paper?
  - 2) Read the title and scan all paragraph headings in the text
  - 3) Write down in your own words what the main topic of the text is
  - 4) Write down what you already know about the topic (prior knowledge)
  - 5) Do you have a clue about what conclusion the text is heading for?
  - 6) Set out a plan for how you are going to read the text:
    - 6a) Think of which parts of the text you are going to read and in what order
    - 6b) Think of which parts of the text you are going to pay extra attention to
    - 6c) Think of which parts of the text you are going to ignore because they are not relevant to your reading goal
  - 7) Start reading, while carrying out your plan
  - 8) Make notes by paraphrasing main ideas of the text:
    - 8a) Explicitly look for relations between ideas
    - 8b) Look for consistencies/inconsistencies between ideas
  - 9) In the mean time, monitor your comprehension of the text:
    - 9a) If you do not understand the meaning of a word, consult a dictionary or infer the word meaning from its context
    - 9b) If you do not understand the meaning of a paragraph, re-read the paragraph, read back to find previous information, or read on to find additional information
    - 9c) Check if your overall comprehension of the text is in line with your reading goal and reading plan (if not, go back to step 1 or step 6)
  - 10) Try to integrate main ideas into a cohesive summary of the text
  - 11) Evaluate your summary:
    - 11a) Does your summary correspond to what you initially thought the conclusion should be (in step 5)? If not, check and see what the discrepancy is between the two
    - 11b) Formulate your own questions about the text to test your comprehension
  - 12) Look back to the assignment: Did you attain your reading goal?
  - 13) If everything tallies, then memorize your summary.
  - 14) Look back to how you have studied the text:
    - 14a) What went well?
    - 14b) What went wrong and why?
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