The Free High School Science Texts: Guide to Studying

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[1]See http://www.fhsst.org

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1 3 Steps to Making Learning Easy

This is your "cheat sheet" for studying! By following the simple guidelines in this booklet, you will be able to **study more effectively** and easily and **improve your marks**. But it's all up to you.

You need to:

- **want** to improve (it's easy!)
- take **responsibility** (its up to you!)
- be **honest** with yourself (only you know what works for you!)

No one can force you to learn something - you have to *want* to do it. *You* are the one who controls your attitude towards learning - if you **want** to do it - you *can*!

Having a good education opens many doors. You are the one who writes the exams and deals with the results - good or bad. No one else can do the work for you - you have to take control of your learning. It's your **responsibility** and your future!

It's easy to make excuses and find reasons why you might not succeed at something. The hard thing to do is be **honest** with yourself about how hard to tried and whether you really did your best and how you can do better in future.

2 The Plan!

There are 3 big areas to focus on in your learning:

1. **In Class** - Listen effectively and take proper notes
2. **After Class** - Summarise, homework, revise
3. **Group work** (at home or in class) - Form a group, pick a topic, teach each other, review

Now we're going to go into more detail on each of the areas:

3 In Class

At school you spend a lot of time in the classroom. If you use this time to focus on your learning, your marks will improve *and* you will have more free time.

The important things to do in class are:

Listen carefully in class

You learn by listening, just think about how easy it is to remember the words to your favourite song. You can learn a lot just by simply listening.

The biggest advantage to listening to the teacher in class is that they *know* what the important points are and they can point them out. They can also answer any questions you have along the way. Keeping up with the teacher's explanation in class saves you from struggling to understand later (just before your test!) and makes revision and homework *much* easier.

Stay focused

Don't be distracted by the teacher's looks, clothes or way of speaking. If you find yourself doing this just *choose* to focus on the lesson.

Also don't be distracted by your friends, whats going on outside the window, or what's for lunch. It's easy to let your mind wander and it will happen sometimes but when it does *force yourself to focus*.

Ask questions

Asking questions helps you to understand things clearly, and helps you to follow what the teacher is saying. Don't be scared to ask the teacher a question if you don't understand something - most likely there are other people in your class who want to know the same thing. However, if you are very nervous, you can note down the question and ask your teacher after class. But whatever you do - ASK THE QUESTION.

Don't give up!

Often we mistake new or different content for difficult content. Don't fall into this trap. If something comes up that you think is difficult accept the challenge and try to listen harder and think more - don't be intimidated! You will probably find it isn't nearly as difficult as you first thought. Open yourself to new ideas and it will be easier to understand new work in class.

3.1 Take notes

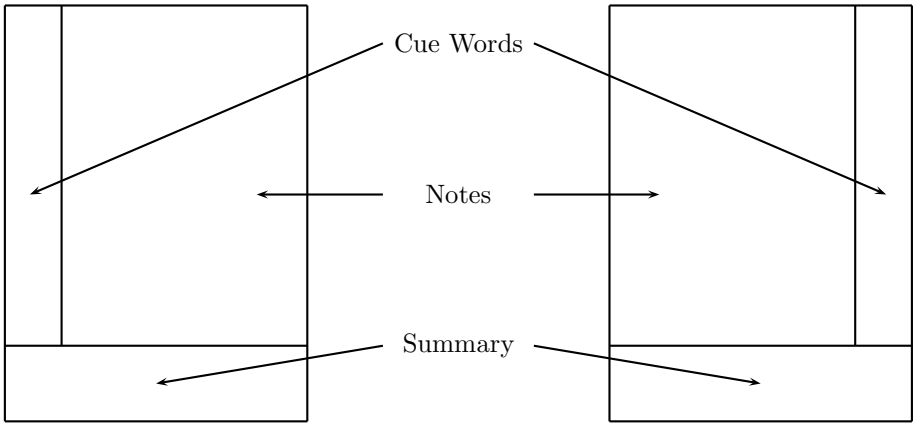
To take notes properly you need to be able to decide what is important to write down. Do this by listening and carefully following the lesson. You also need to be able to write clearly and quickly (write neatly!), so that you can use your notes properly later to help you study.

Layout of notes

There are many methods for taking notes. This is the Cornell Method which you can use straight away without planning ahead for your lessons.

Here is what you do (have a look at the picture to follow along):

- Divide up your pages so that you have a large area to write notes, a summary block at the *bottom* of every page and a **cue word column** on the *outside* of every page. A 'cue word' is something that will remind you about a particular idea or concept. Your pages should look like the examples below.
- When you take notes in a lesson write in the **notes area** and ignore the other areas. Even if you are copying down notes specifically written by the teacher you should only use the notes area.
- The summary block and cue words column will be used when you revise later.



This method will:

- make it easier to find information
- make your work more organised
- help your revision, (and therefore improve your marks)

Hints about what to write down

If the teachers tells you to write something down, do it. If the teacher writes an example or explanation on the board, write it down. If the teacher uses a new word, write it down and write the meaning down. If you don't know the meaning ask immediately, it might be very important. If a teacher keeps repeating something that you haven't written down, write it down, its probably important.

Shortcut notation

Sometimes note-taking is hard because it takes time to write all the words down while the teacher is speaking. One way to speed up note-taking is to reduce long words to shortened forms (*abbreviations*) or symbols. We recommend that you use standard notation for many everyday words. Here is a table of standard

abbreviations:

Word(s)	Abbreviation/Symbol
approximately	$\sim$
because	$\because$
include / includes / including	inc.
example	eg.
implies	$\Rightarrow$
therefore	$\therefore$
with	w/
without	w/o
important	NB
that is	i.e.
especially	esp.
Left hand side	LHS
Right hand side	RHS
between	btw.
perpendicular	$\perp$
parallel	$\parallel$
if and only if	iff
greater than	$>$
less than	$<$
Add your own!	

This list is far from complete. You can make up your own short forms for words you use often - as long as you remember what they mean! Add them to this table so you can refer to them whenever you need to.

4 After Class

To do your homework and to study effectively (and more quickly) it's important to find a place and time of the day which is as free of distractions as possible. e.g. Dinner time is NOT a good time to start your after school work!

This is your time you are using to do work so don't let it be wasted because of a distraction. Remember: distractions mean longer work time and lower quality work. TV, music, the radio, phones are all means to turn your attention away and help you avoid working! It's up to you to stop this from happening! The key here is to focus, get it done and then enjoy your free time any way you like!

Routine

The simplest way to help yourself focus and work consistently is to establish a routine. To do this you need to plan your days - Decide what time you are prepared to set aside each day - and *stick to it.*

It takes 2 weeks to form a habit - once you're in the routine, it's easy! That means you have to keep working at improving your study methods for two weeks

before you'll see the real results.

People can concentrate properly for up to 45 minutes at a time - after that time, the brain needs a break! Break your after-class work time into 45 minute chunks and take a short break in between to stretch, have a drink etc. before continuing.

The 3 key actions to do in your after class work are:
Summarise, Homework, Revise!. We will explain how below:

4.1 Summarise

Before starting your assigned homework, or any studying, **summarise** what you did that day in class. You do this because it revises what you were taught and prepares you for your homework. Reviewing the work while it is still fresh in your mind by *summarising* store it in your long-term memory.

Using the Summary section and Cue words

Take out the pages of notes you made in class during the day. Then:

- Read through each page one at a time
- In the summary block at the bottom of each page, write one or two summary sentences in your own words describing the main points in your notes.
- In the cue word column, write one **cue word** for every new topic or concept on that page (**It stands out more if you use a different colour pen!**)

The summary sentences help you pinpoint the main ideas and remember them. The cue words help you easily find things when flipping through your notes at any time.

For example, if your notes on one page discuss Newton's Third Law you might write "Newton's 3rd" as the cue word and the summary sentences as:

"Newton's 3rd law says all forces occur in action-reaction pairs. Action-reaction force pairs are always equal in magnitude and opposite in direction. (think about leaning against a wall)"

4.2 Homework

The purpose of homework is to help reinforce what you learn in class and for you to practise solving problems (which is important training for your exams). You can use your homework to help you find where your strong and weak points are and focus on improving. If you don't know what the problem is, then you can't solve it! Try to follow this **checklist process** when you do your homework:

4.2.1 Using checklists

Making a checklist is a simple technique to be your own coach. It is just like when you train for a sport your coach manages what you should and shouldn't do and corrects your mistakes as you go along. This technique will make it quite easy to be your own coach and will let you:

- analyse your technique
- compare it to correct standards
- decide where your weak and strong points are
- allow you to track your strengths and weaknesses and continuously improve

Making your checklist

For each subject you have homework for, get 2 blank pages. One is the **strengths** list, these are things that you do correctly and should keep doing. This is the list that you use to reinforce the positive things you do.

The other page will be the **weaknesses** list. These are things you do wrong or forget to do and need to correct or start doing.

Keep these pages in a safe place - keep using the same pages for each subject. (You don't have to make a new one each day!) How to set up the pages is shown below:

Subject: Physics List type: Strengths

Summary	Reason	Check

What to put on your checklist

The first step of making a checklist is to analyse some part of your work. Do this as follows:

- Find a problem that you already have a *model solution* for, or use a worked example for a textbook or your notes.
- Without looking at the answer, try to solve the problem, writing down all your steps (don't cheat!)
- Then compare your answer to the model answer:
  - For each step in the model solution, find the purpose for it.
  - For each step you got right, write a short summary of the step and its purpose in the columns on your *strengths* checklist page
  - For each step you got wrong, write a short summary of the step and its purpose in the columns on your *weaknesses* checklist page

Our solution (Wrong!):
1) Convert volume of bottle into S.I. units:

$$\begin{aligned} 1dl &= 0.1l \\ 20dl &= 0.1 * 20l \\ &= 2l \end{aligned}$$

2) Calculate the volume of Coke:

$$2l/\frac{1}{2} = 4l$$

3) **Answer:** 4 l of Coke
Model solution:
1) Convert volume of bottle into S.I. units:

$$\begin{aligned} 1dl &= 0.1l \\ 20dl &= 0.1 * 20l \\ &= 2l \end{aligned}$$

2) Calculate the volume of Coke:

$$2l \times \frac{1}{2} = 1l$$

3) **Answer:** 1 l of Coke

Example: Calculate the volume (in S.I. units) of coke in a bottle if the bottle is half full and holds a maximum of 20 dl.

Let's make the **strengths** and weaknesses checklists for the example above:

Subject: Maths List type: Strengths

Summary	Reason	Check			
Unit conversion	Always work in S.I. units				

Subject: Maths List type: Weaknesses

Summary	Reason	Check
Using fractions	Divided by $\frac{1}{2}$ instead of multiplying!	

There are two reasons we write down the good things:

1. to remind ourselves for the next time
2. sometimes you do the right thing without understanding it properly, we need to identify why it is correct and make a habit of always doing it

If you see a place where you went wrong and you understand the reason for the step in the model solution then add it to the **weaknesses** side of your checklist. These are things you need to do but haven't yet got into the habit of doing. the goal is to identify these problems and fix them permanently. When it is time for exams there should be no items left on the **weaknesses** side and a complete set of things on the **strengths** side!

Using your checklist

Now you're ready to start your homework. Get out your checklist pages for the subject you're going to do homework on and read through your list of strengths and weaknesses. You will be reminding yourself of what you do right and what you must be careful to avoid and this will stop you making the same simple mistakes over and over again. (This is your self-coaching part!)

When you use this method, you need to be your own coach. Be very honest with yourself. If you leave out things you don't like, feel embarassed about or don't want to admit then the method will fail. Be honest and keep your checklist to yourself if you feel self-concious about it.

Checking yesterday's homework

Review the last set of marked problems for this subject and udate your strengths and weaknesses lists as we've explained. This is how you remind yourself what things you did correctly and where your mistakes were.

If there is something on your strengths list which you forgot to apply - then put a cross next to it on your strengths checklist. If you get 3 crosses, then you must move this strength to your weaknesses checklist because you've forgotten it too many times and it's not honest to call it a strength anymore.

If there is something on your weakesses list that you have avoided (i.e. you got it right!), then put a tick next to it. When you have got 3 ticks in a row, then move it to your strengths list - now you're making progress!

Doing today's homework

Now you have a list of all the things you did right and wrong in your previous homework and you can make sure you do the same things right and avoid making the same mistakes again! This way, you can help yourself get closer to the right answer! The first few problems might take a little longer than usual, but you will get faster as you remember what to do and what not to do!

Most time is wasted because people repeat simple mistakes often. This method is more careful and might look slower but soon you won't be making the silly mistakes any more and you'll get problems right the first time.

When you have completed a problem and you are checking your checklist make sure you do the following:

- did you check your checklist before starting the problem. If not try to decide for yourself why not and decide how you are going to make sure you do check it in future.
- did you do all the Strengths things again. If not try to decide why you didn't. Decide what you can do to ensure that you do them in future.
- did you make any of the mistakes that are on the Weaknesses list? Try to decide if they are actually the same mistake and try to see why you made it again. If this is a different weakness add it to the Weaknesses list so you remind yourself not to make that mistake again

Having the checklist and using it after every problem is like having a teacher watching you and immediately pointing out where you go wrong and where you go right. You need to use it constantly if you want to improve your learning skills.

4.3 Revise

The final part of after class work is to spend a little time doing revision. The earlier you start the easier the work is to remember and understand fully. The goal is to be properly prepared for your tests and examinations. If you do this in a regular and planned way it is much easier.

Identify your next two tests. These are the priority subjects at the moment. You need to start revising the work for those subjects. You need to spend some time on them after you have finished your homework, only do one subject each day but alternate between the two subjects on different days.

In this revision you should read your notes carefully and then read the summary sentences to check if you think they are as accurate and correct as possible. If you find that something should be written differently fill it in or write it in the margin in a different colour.

This will make sure that you know the work well enough to improve the summary sentences and identify any important points you missed the first time round. It will also make sure that the work is ingrained in your long-term memory.

5 Group Work

There are many benefits to studying and working with other people - many brains are better than one brain. But there are also many distractions. Agree

with everyone when you first organise it that you want it to be as short, efficient and effective as possible. This means focusing on the work and getting it done, having people to work with makes this more enjoyable and you can support each other. Plan before you meet exactly what sections you are going to work on.

The first thing to do in the meeting is discuss the most important concept in the sections you are working on. This should be a short discussion with everyone giving their opinion and then agree quickly on the key principles, laws or techniques. Now you know where to start.

Now you can begin working through problems. It's best to start with problems for which you already have the answers (such as worked examples from a textbook or your notes, or past tests).

- Everyone should do the problem on their own - with no help or discussion with the others.
- When everyone is finished, one person should lead the others through the model solution (you can each take in turns to do this).
- Discuss and try to understand each step of the model solution and each person can compare their approach to the problem.

In this way you can all learn from each other about what to do and what not to do, and learn from each other's mistakes/successes. This is like combining everybody's checklists by talking about it rather than writing it down! Sometimes you or your friends can explain something in way that you understand more easily than in class. You can help each other!

Then repeat this procedure with another problem.

6 Group Discussions / Debates

Being able to hold a proper discussion, get your views across clearly and understand other peoples' points of view are very valuable skills that you can use, not only at school, but in all areas of life.

Everybody can tell you how to pass a soccer ball or take a penalty shot but it takes practice to do it properly. It is the same when we are learning to think like a scientist. We need to practice the skills so that they will come to us easily when we need them in everyday life, not just tests and exams.

It's very likely that your teacher will ask the class to discuss topics in class, and these pointers will help you make your case clearly and help you learn from others. You can even use the methods below to practise with your friends when you do group work.

So what skills then, are we going to work on? We will practice how to:

- explain principles and methods
- listen critically to explanations
- help each other to further our understanding

Scientists don't have all the answers and there is nobody for them to ask. By explaining their work to each other and learning from each others' successes and mistakes, scientists are able to continue to expand their knowledge without

any single scientist knowing all the answers. We are going to work in groups to learn how to explain to each other, how to listen and give feedback to each other and how to improve our understanding without necessarily knowing the final results when we start. It will also lead you to the questions you need to ask!

Even if you don't know the answer, doing this exercise will help you revise what you do know, clarify your understanding, better remember the content you have learned and it will actually improve your knowledge. All you have to do is do each part the best you can and the rest will come naturally! Studies have shown that you remember and understand more things if you discuss it and try to explain to others.

Below is a flowchart showing each step of the process that is involved in the exercise:

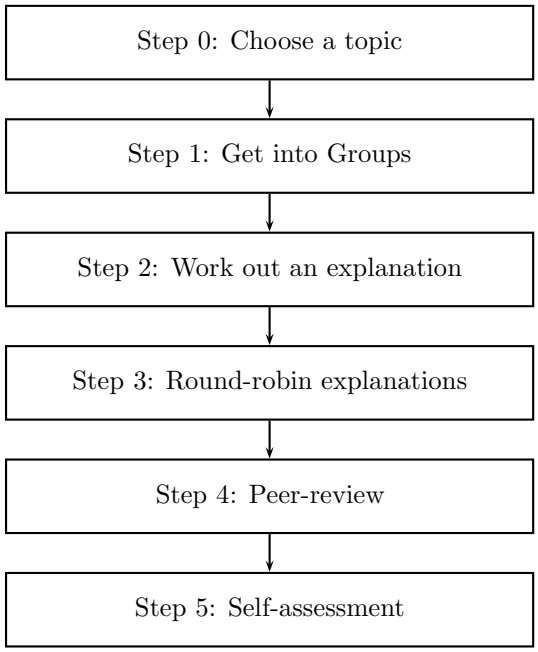


Figure 1: Flow chart of steps in Group Discussions

6.1 Choose a topic

Guidelines:

- The first topic should be a very simple one so that everybody can get used to the procedure.
- The topic needs to be either a problem or principle that can be explained in 5-10 minutes

- It can be something that you are trying to understand or a worked example from class
- Even if it has been covered before, working through it again is great revision and improves your understanding

For example, discuss Newton's Third Law: If I push on a lawn mower, it pushes back on me with an equal, but opposite force. Explain why we don't both just stay still (Hint draw ALL the action-reaction pairs). An example from chemistry could be: A solution of sodium chloride is able to conduct electricity, but an alcohol such as ethanol is not. Explain this phenomenon.

Other topics might include:

- Explaining laws or principles for example:
  - Physics:
    - Newton's Third Law
    - Snell's Law
    - What is a vector?
    - Difference between distance and displacement with examples
  - Chemistry
    - Le Chatelier's Principle
  - Mathematics
    - Explaining the strategy for solving a particular problem
    - Broader scientific related topics

6.2 Get into groups

Guidelines:

- Form random groups, if you can, because this helps you become comfortable talking to different people.
- This is not a dangerous exercise, you will be safe if you form random groups and you only work with people in the same grade as you!
- If you have a small study group then it's fine to just form one group.

6.3 Work out an explanation

Guidelines:

- The group should take 5-10 minutes for everyone to work on their own explanation on paper.
- The important part here is for everyone to explain as much as they can about the topic, starting in small steps. You can use your notes to help you at this stage.
- It does not matter if you can't explain everything. Just start with the basics and see how far your thinking takes you. It is the action of doing your best that is the important thing!

In the first example that was given above, you might start by asking questions such as,
What is the definition of Newton's Third Law? or
How does the law apply to this case?

In the second example, you might ask
"What is needed for a current to flow through a liquid?" or
"What is different about the liquids that are mentioned?".
This may lead you to ask
"How does bonding in each liquid affect electrical conductivity, and how can this be applied in this example?"

From these questions, you should be able to build on your understanding of the problem one step at a time. Remember that most scientists don't know all the answers when they start either!

6.4 Round-robin explanations

Guidelines:

- Randomly choose one person to start, and move clockwise around the group until everyone has had a turn to explain as much about the problem as they can. (If you get nervous speaking in front of a group, take a look at the section at the end of this chapter for some advice.)
- It is important that nobody should interrupt while another person is speaking, as explaining helps each person to understand, and gives them a chance to think of questions to ask.

If you are not the person who is explaining, then you should:

- listen carefully (Refer to the section on 'listening' at the end of the chapter for some advice on how to develop your listening skills)
- even if the person speaking makes a mistake - don't interrupt them!
- write down at least one thing that you agree with in the explanation
- write down at least one thing that you disagree with in the explanation

When the speaker is finished all the listeners can ask questions if there is something they didn't hear or understand. This is not the time to disagree or debate the explanation. Then go on to the next speaker until everyone has had a chance to give their explanation.

6.5 Review and Feedback

Guidelines:

- Now go around the group in the same order as you did for the explanations.
- Now each person will have the opportunity to say what they agreed with, and what they disagreed with, for each speaker.

- Each learner should make notes of the comments that are made about their own explanation.
- Ask questions if you don't understand the feedback.

This is the time when learners should try to understand what other people agreed with and didn't agree with. This information will be useful to improve their explanation. IMPORTANT: If things are uncertain (like half the group thinks something is right and the other half thinks it's wrong, then make a note of it and look it up in your books or ask your teacher.)

6.6 Improving your explanation

Guidelines:

- Each person will now have the opportunity to improve on their explanation using the comments and feedback from other members of the group.
- Each person should try to see if they can solve any disagreements people had with their explanation without losing the things people agreed with.

You should try to use all the feedback and questions to improve on your explanation. With an open mind you will be able to clarify and extend your explanation and understanding.

6.7 Group consensus (Optional)

If you are asked as a group to discuss your ideas on a topic then you can do the following:

Guidelines:

- Now the group should work together to combine your thoughts into one explanation.
- As a group, appoint a representative to present your combined explanation to the other groups or class.
- The group should construct questions to ask your teacher or tutor about the things that you don't understand.

Additional information

There is a lot that can be done to improve how efficiently groups communicate and how effectively they are able to do these exercises. Here is some advice on various aspects that everyone should read and check periodically. It is best to do the group exercise first so that the advice here has context before doing the first proper exercise with a topic from class.

Speaker apprehension

Many people are nervous (apprehensive) about speaking or explaining to a group of people. Often this is clear through the speaker predicting they will fail and also trying to participate as little as possible. This is counter-productive but there are many techniques which can be used to overcome apprehension.

The more someone speaks the more confident they become. One basic strategy is to jump right in and speak often enough that you no longer feeA nervous. This is a long term solution. Using the short term solutions to get through speaking a few times will achieve the long term goal of becoming more confident and comfortable speaking.

The short term strategy for nervous speakers is to:

- Try to understand what makes you feel nervous about speaking. Think about it and evaluate how you respond how you would like to respond.
- Be realistic about what you expect to produce and what your audience expects and can produce. You aren't competing with the other speakers so if you speak second you don't have to do better than the first speaker but you do have to do better than your first time!
- Breathe deeply, this naturally releases tension and slows your heart beat. A few deep breaths can relax you considerably.
- Gain experience and practice.
- Prepare as well as you can (in the exercise we have above you don't have lots of time to prepare but when you do you should make full use of it). The better prepared you are, the more confident you will feel, and you may feel less anxious.

Listening effectively

Hearing and listening are different. Just because you heard something doesn't mean you understood it or will remember it. Hearing or receiving is only the first stage of listening.

It is important that you:

- focus on the speaker's message
- avoid focusing on distractions in the environment
- don't focus on questions you want to ask. Make a quick note so you will be reminded, and then re-focus on what the speaker is saying.
- relate what the speaker is saying to what you already know
- are open-minded. Listen to the opinion of the speaker and try to see it from their point of view. Don't just switch off because you disagree. You might miss out n valuable information.
- don't fall into the friend-or-foe trap by listening only for positive things about some people and only negative things about others.

Feedback can be constructive. Sometimes people are reluctant to give feedback because they may be:

- unsure of their feedback
- avoiding confrontation
- unwilling to take a stand others can see

Feedback or criticism can be very positive because. You are giving the speaker another perspective or view. Receiving feedback or criticism can also be difficult so we will try to give advice on how to give it properly (and how to receive it).

Giving criticism that is useful and positive means following a few guidelines:

Say something positive: egos are fragile and speaking in front of people is a personal experience and so people can be easily offended. Just saying it was wonderful doesn't help either. Emphasise something good in the explanation.

Be specific: don't just say that you thought it was a good or bad explanation. Say something like I liked the way you explained the whole picture, then each piece individually and then the whole picture again, it made sure I could see how everything fits together.

Be objective: do your best not to be biased. The person may have spoken well and explained very clearly but not agreed with you. Don't attack something which disagrees with your view. Also don't let yourself be fooled into only giving positive feedback to people who agree with you.

Limit criticism: providing one positive and one negative feedback item limits criticism. It stops people from feeling attacked. If you talk for 5 minutes and someone had 20 negative things to tell you them you will feel attacked and stop listening. It is more effective to get a few points across than none at all and stop any further discussion.

Be constructive: always offer your perspective on anything you think might be useful to improve the topic of criticism. Even if you don't know a solution you might know where to look or who to ask about it. Accepting criticism or feedback is as hard as giving it. Accepting that you can learn and improve by listening to feedback and trying to understand where it comes from can help you improve and so is a worthwhile exercise for you. Even if you don't like the feedback you can still use it to benefit yourself.

Accept the critics viewpoint: if a critic says they weren't convinced don't argue with them. They weren't convinced, instead try to see why they weren't convinced and what you could do to more effectively get your point across.

Don't be defensive: the more aggressively you defend what you said the less you listen to what other people are saying and the more closed-minded you become. Try to be objective and not attached to what you said during the feedback stage.

Don't be self-critical: the feedback is not about you as a person it is just about an explanation. No explanation is ever perfect and different explanations will be more effective for different people. Any explanation can receive criticism, but listening to the criticism is the key to improving.

Seek clarification: ask if you don't understand the feedback. You must be clear on what the critic is actually saying otherwise you can't improve based on the feedback. Wait for the critic to be prepared to accept questions rather than just interrupting them, don't be distracted by your own questions, try to listen effectively.