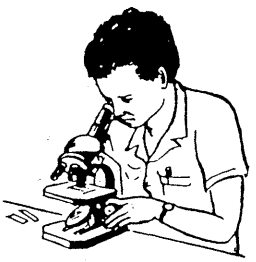
CHAPTER 17

Solving Problems Step by Step (Scientific Method)

A health educator in Zaire, Africa writes:



"We are wrestling with some very difficult problems in the education of auxiliary health workers . . . The frame of reference of the young people we train is so vastly different from our own. Ours is a physical, technical one; theirs is more traditional and spiritual . . .

"Deductive [step-by-step] reasoning is a real problem for them. They can perceive cause-and-effect relationships within their traditional frame of reference, but only with great difficulty in the physical and technical frame of reference. Therefore, problem analysis and problem solving are very difficult . . .

"Our problem is, therefore, to understand their learning processes, how they interpret given information and how they can be stimulated to think and analyze in a different frame of reference. We must adapt our teaching methods to their situation . . . We need to discover how to develop better practical training in problem analysis and solving. In mathematics, how to calculate a dosage or a time interval; in clinical medicine, how to analyze a patient's signs and symptoms in order to come up with a correct diagnosis; in health, how to approach the health and development problems of the community . . ."*

Problem-solving skills are among the most basic skills a health worker can master. By this we mean **the ability to look carefully at a situation, analyze what problems exist, and determine steps to improve the situation.**

The main focus of health worker training needs to be on learning problem-solving skills.

This means that, whatever the subject, instructors need always to **relate what students learn to the work they will do in their communities.** The main job of the health worker is to help people better understand and resolve their problems.

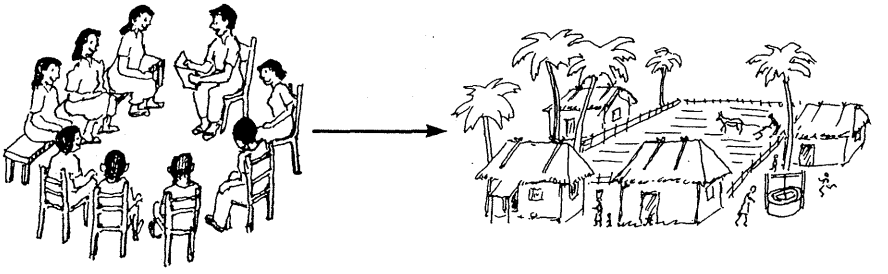
*From personal correspondence.

Too many training programs have students concentrate on memorizing facts or performing 'clearly defined tasks', rather than learning problem-solving skills. Even when problem solving is emphasized, often learning takes place mostly in the classroom, rather than where people's basic problems occur—the home, fields, water hole, clinic, jail, etc.

Today, many training programs are moving the focus of learning out of the classroom and into the village, the street, the home, and the clinic. From the first, students begin to work with real problems of real people. In this way, learning about solving problems becomes urgent and meaningful.

The focus of health worker training has been changing:

from **memorizing facts** . . . . . to . . . **mastering specific skills**
from **studying about problems** . . . to . . . **practice solving real problems**
from **classroom learning** . . . . . to . . . **field and village experience**



Learning to solve problems is often best done through practice and experience in the community. But some classroom learning is helpful, too—especially if approached in an active, exploring, and realistic way.

Suggestions for helping develop thinking and problem-solving skills in the classroom:

- Teach (even basic information) through **role plays and sociodramas** rather than through lectures. Have students act out lifelike problems and practice solving them in a lifelike way (see Ch. 14).
- **Invite people from the community into the classroom.** Farmers, mothers, children, experienced health workers, and others can talk with the students about their needs and problems.
- **Use a dialogue or discussion approach to learning.** Help students build on their own experience and put what they already know together in new ways—like pieces of a puzzle.
- Use teaching aids that do not simply demonstrate or show things, but that **invite students to figure out answers for themselves** (see p. **11**-13).
- Teach by asking questions (whether in discussions or in exams) that **encourage thinking and problem solving** related to needs in the students' communities (see p. **9**-3).

In the classroom, it is also a good idea to explore with health workers the steps involved in a scientific approach to solving problems. The group can compare how this scientific method differs from the traditional approaches to problem solving they have observed or practiced in their own communities.

In this chapter, we will look at ways of helping people with limited schooling to understand the process and purpose of scientific method. Once again, our job is to **relate learning to familiar experiences.**

SCIENTIFIC METHOD— A STEP-BY-STEP APPROACH TO PROBLEM SOLVING

A careful, step-by-step approach is essential to the accurate diagnosis and treatment of different illnesses. It is also useful for analyzing and dealing with other problems in a community.

To take a scientific approach, the health worker needs to **start by asking searching questions rather than by jumping to quick answers.** At first this may be difficult or confusing for a person whose experience has been mainly in traditional or folk medicine. Herb doctors and traditional healers generally depend on **faith, magic, and the power of suggestion** as a large part of their curative art. People's belief in the instant knowledge of the healer may be as important to their cure as the herbs or medication used. For this reason, the healer tries to show that he or she has immediate understanding of the illness, its cause, and its treatment.

But while the traditional healer tries to be certain about the illness from the first, **the scientific healer starts with uncertainty or doubt** about the nature of the illness.

Traditional approach:
START BY KNOWING

Part of the art of TRADITIONAL HEALING is to be certain about what the illness is and what to do about it. This gives the sick person and his family strength and confidence that can help overcome the illness.

Scientific approach:
START BY NOT KNOWING

Part of the skill of SCIENTIFIC HEALING is always to have doubt about what the illness is. Through questions and step-by-step search, the healer tries to find the most likely cause and most effective treatment.

NOT THIS 

In scientific problem solving, it is important to start with doubt and then systematically gather information to figure out the most probable answer.

 BUT THIS

Helping health workers learn to solve problems in a questioning, step-by-step way is not easy. Many find it difficult to accept uncertainty as a starting point. They may be ashamed or afraid to admit their uncertainties—even to themselves. Instead they may jump to 'obvious' answers, or even invent test results for things they have not understood. ***Appearing to have the answer*** somehow seems more acceptable than ***doubting and carefully searching for one.*** This is an attitude the health workers may have learned in school, where good grades tend to be valued more than useful knowledge.

This leap-before-you-look approach to problem solving, when mixed with modern medical science, can give poor or dangerous results. For this reason, some health professionals argue against teaching village health workers to use important medicines or take on major responsibilities.

However, **a reasoning, step-by-step approach to problem solving can be learned.** It can be learned by non-literate persons just as by medical students. One reason why it sometimes presents special problems for villagers is that, in a training situation, they often feel unsure of themselves. This is especially true when instructors are professionals from a 'higher' level of society, or use manners, dress, and language that make villagers feel inferior. Persons who feel unsure of themselves, understandably, may have greater difficulty admitting their uncertainties. They fear being laughed at or scorned for what they do not know. Afraid to ask questions, they may try to guess at answers.

For this reason, **development of problem-solving skills needs to go hand in hand with group learning methods that help build self-confidence and greater social awareness.**

EXPLORING THE SCIENTIFIC METHOD OF PROBLEM SOLVING

Rather than starting off by explaining the steps of scientific method with big words (***hypothesis, theory,*** etc.), try looking at a real or imaginary situation in which the different steps are used. Then encourage the health workers to figure out the various steps for themselves.

It is best not to begin with the diagnosis of a medical problem, as this is still a strange new process for many students. Instead, try to begin with a more familiar problem-solving situation. In Ajoya, Mexico, the village team uses a 'detective story', and the students take part in figuring out who is guilty. After analyzing the different steps in the story, the group discusses how they can use the same problem-solving methods in diagnosing and treating people's illnesses.

A detective story: "WHO STOLE THE GUALAMO JAM?"*

This story is used for helping health workers learn about the scientific method of problem solving. It is not simply told by one person; rather it is created together by the student group. You can use drawings to give it more life. The story will turn out somewhat differently with each group, but may develop something like this:

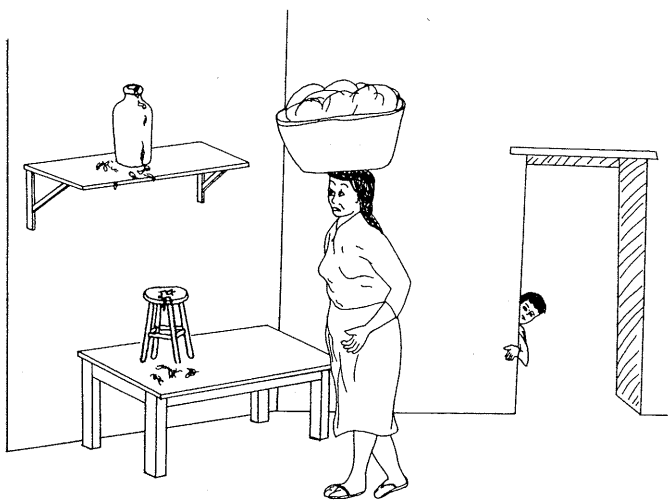
Instructor: Who knows what a detective is?

A student: Isn't it someone like a policeman who tries to figure out who committed a crime?

Instructor: Right! Well, this is a sort of 'detective story' that could take place in a village home. The mother is the detective.

Let us suppose that one morning Mama prepares a batch of ***gualamo*** jam for her husband's birthday.

Then she goes to the river to wash clothes.



In the afternoon Mama comes back from the river. She sees that someone has been into the jam and made a big mess.

What is her first idea about how this happened?

**Gualamo* is a black, grape-like fruit that grows wild on trees in western Mexico.

Students: That one of her children stole the jam.

Instructor: How can she find out which of her 7 children did it?

A student: She could call all the children and ask them.

A student: But what if they don't tell?

A student: Or what if the one who did it lies and says someone else did it?

A student: She could find out what the children were doing while she was at the river. Maybe some were away so she can be sure they didn't steal the jam.

Instructor: Good! Let us suppose she finds that one of the children was away gathering firewood and has the wood to prove it. And that another was at her grandmother's house. But the others were all at home. How many possible culprits does that leave?

A student: Five.

A student: Why doesn't she look at their hands and mouths? Gualamo leaves a purple stain.

Instructor: Good! Suppose she finds that 3 of them have purple stains on their fingers and tongues. Then what?

A student: Punish all three!

Instructor: But suppose each one says he didn't steal the jam; that another gave it to him. How can Mama be sure which one actually stole it?

A student: Maybe the one who did it left handprints in the kitchen, so she can tell which one it was.

Instructor: Good! But what if the 3 children's hands are all about the same size? Then what?

A student: I've heard that real detectives take fingerprints. Maybe she could take their fingerprints with ink . . .

A student: . . . or with the jam itself! Then she could compare the prints of each child with the prints in the kitchen. That would be a good test!

If some students don't know about fingerprints, and if there is time, the instructor can have students actually take each other's fingerprints. They can use ink or jam and act out the 'test' to see which child stole the jam.

fingerprints of the three children

1. 

2. 

3. 

jam print in kitchen

Which child do you think stole the jam?

Instructor: Fine! Let's say the fingerprints are a little blurred, but that after doing the fingerprint test Mama is almost sure that one boy stole the jam. What should she do next?

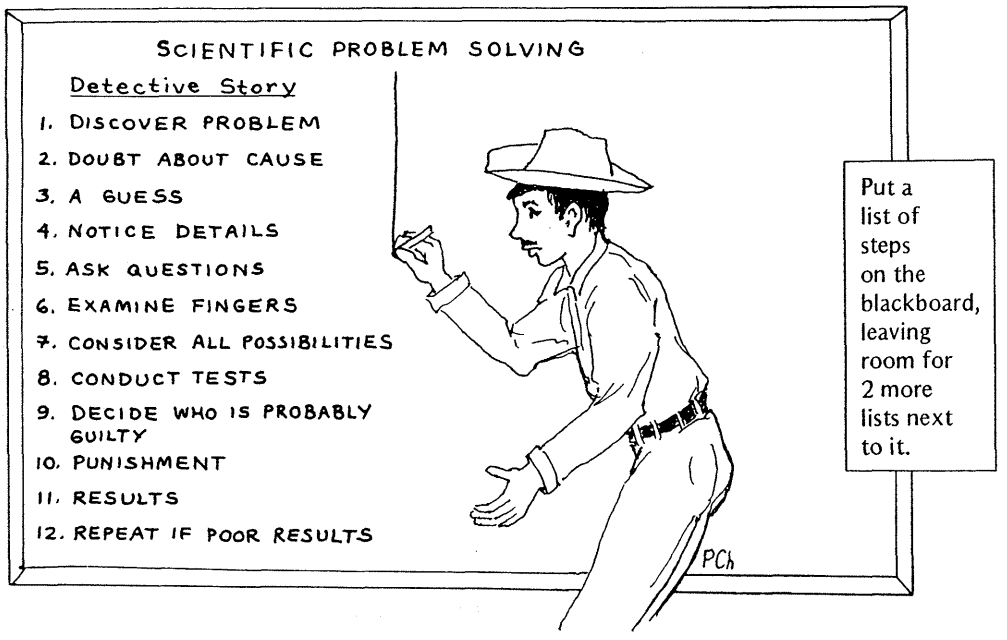
Students: Punish him!

Instructor: And after punishing him, how can she tell if she was right about who did it, and if the punishment was effective?

A student: By seeing whether any more jam is stolen!

After the 'detective story' has been completed, the instructor helps the students analyze the various steps that Mama took to find out who stole the jam. The steps will be something like this:

1. Mama **becomes aware** of the problem.
2. She **is uncertain** about how it happened.
3. She **guesses** that one of her children is responsible.
4. She **notices** the details or 'evidence'.
5. She **asks questions.**
6. She **examines** her children's fingers.
7. She **considers all possibilities.**
8. She **conducts tests** to prove or disprove the different possibilities.
9. She **decides** who is probably guilty.
10. She **provides punishment.**
11. She **sees the results:** Whether or not punishment was effective.
12. She **starts over again** with step 1 if the punishment was not effective.



A second detective story: A HEALTH PROBLEM

After discussing the steps Mama took to solve the *gualamo* jam mystery, students can compare these with the steps in the diagnosis and treatment of a health problem. This can be more fun if done as a role play with a student or instructor pretending to be sick. For example:

A 40-year-old woman arrives complaining of severe pain in her belly. What steps might a health worker take to figure out the cause of the pain and what to do about it?

Following the general outline of steps Mama took in the first detective story, the learning group tries to diagnose the woman's problem. The steps they develop in this new story or role play might be as follows:

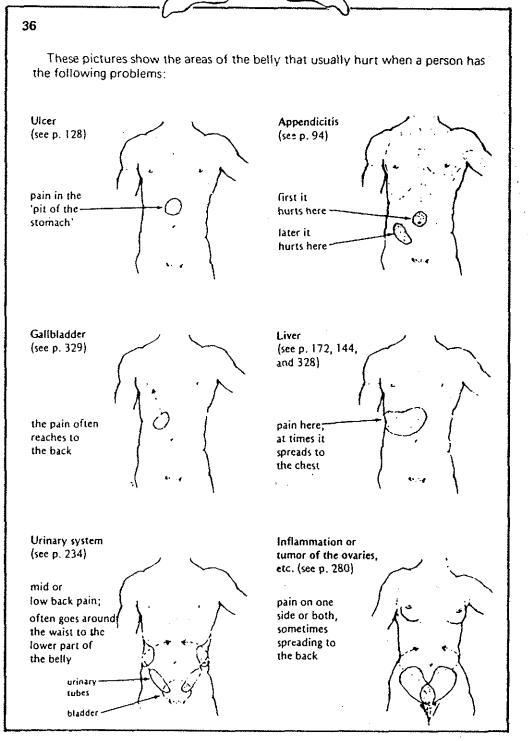
1. **Main complaint.** (What bothers the sick woman most?)
2. **Doubt or uncertainty** about the cause. (Start by **not** knowing.)
3. An **idea** or **guess** about the possible cause or causes. (This idea may change as more information is gathered.)
4. **Observation** of the person. (How ill she looks, skin color, etc.)
5. **Questions** (clinical history). For example:

   When did the problem begin?

   Have you had it before?

   What part of the belly hurts most?

   Vomiting? Appetite? Fever? Other symptoms?
6. **General physical examination** (temperature, pulse, location of pain, etc.).
7. Consider carefully all the **possible causes** that are most likely. For example:
   - gallbladder disease
   - ulcer or indigestion
   - hepatitis or other liver disease
   - appendicitis or gut obstruction
   - gut infection



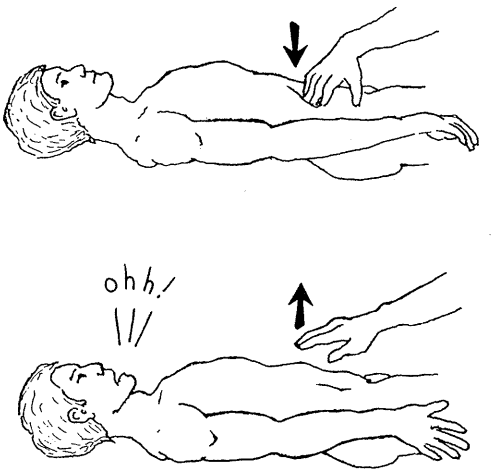
To help consider the possible causes of this problem, students can look at page 36 of *Where There Is No Doctor.*

8. **Specific tests and examinations, and more questions** to help find out which of the possibilities are most likely or unlikely to be the problem.

   Depending on the location, type, and duration of pain, and whether or not there is fever, diarrhea, or vomiting, some of the possible causes may be eliminated.

   For the possibilities that remain, sometimes specific tests can help. Examples are the 'rebound test' for appendicitis (see *WTND,* p. 95) or the 'urine foam test' for liver or gallbladder disease (p. **5**-15 to **5**-16 of this book). Even for less likely possibilities, it is wise to check using simple tests when you can.

   Sometimes health workers will not be able to perform necessary tests. In these cases they should consider sending the sick person to a clinic, laboratory, or hospital that can do what is needed. Be sure to discuss this.



rebound test as shown in *WTND*

9. **Diagnosis.** Decide (if you can) which cause of the problem is most likely.

   It is important that the diagnosis not be considered a certainty, but rather a **strong probability based on all information and tests.** Be ready to reconsider the diagnosis whenever you get new information.

10. **Management or treatment.** Your decision to give treatment or to refer the person to a hospital or larger clinic will depend on:

    - how sure you are of the diagnosis,
    - how serious the problem seems, and
    - distance, economic considerations, personal factors, etc.

    Be sure to include **preventive information** and **health education** along with treatment, when appropriate.

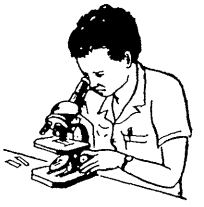
11. **Results.** Carefully observe the results of management or treatment of the problem. If results are good, the diagnosis was probably correct.

12. **Repeat** the problem-solving process if treatment fails.

To make this diagnostic 'detective story' more real, the person pretending to be sick should supply a clinical history and test results typical for one of the possible causes of the woman's pain—gallbladder disease, for example. Then the students can actually follow the step-by-step method to diagnose her illness.

To clearly show the comparison between the ***gualamo*** jam story and the diagnosis, list the problem-solving steps of each on the blackboard (or on a mimeographed sheet). But please do not just copy the list below. Use one based on your group's suggestions. The steps may be fewer, more, or in a somewhat different order.

SCIENTIFIC PROBLEM SOLVING



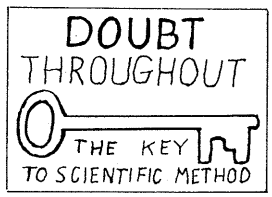
Detective Story	**Health Problem**	**Example**
1. Discover problem	1. Main complaint	Pain in belly.
2. Doubt about cause	2. Attitude of doubt	What could be the cause?
3. A guess as to who did it	3. A reasoned guess as to the cause	Most likely to be gallbladder disease or stomach ulcer.
4. Notice details (sticky handprints, etc.)	4. Observation of person	How sick, fat or thin, skin and eye color, etc.
5. Ask questions	5. Clinical history	Many questions: age, when problem began, how, is there vomiting, etc.
6. Examine fingers	6. Physical examination	Temperature, pulse, location of pain, etc.
7. Consider all possibilities (one of the 3 children with jam-stained fingers)	7. Consider all possibilities (and make a list of them)	• gallbladder disease • ulcer or indigestion • liver disease (hepatitis) • appendicitis • gut infection
8. Conduct tests (fingerprints)	8. Specific tests, exams, and questions	'Rebound test' for appendicitis, 'urine foam test' for liver or gallbladder disease, etc.
9. Decide who is probably guilty	9. Diagnosis	Probably gallbladder disease.
10. Punishment	10. Management or treatment and advice	Pain killers, antibiotic (if she has fever), advice to avoid fatty or rich food.
11. Results	11. Results of treatment	Pain goes away and does not return (except once, when the woman eats fatty food).
12. Repeat if poor results	12. Repeat problem-solving process if poor response.	Woman's good response shows diagnosis was probably right.

Follow-up to the two 'detective stories'

After the first class on scientific problem solving has been given, use every opportunity for students to try the new method. Several follow-up classes may also be helpful. The group can act out additional role plays to practice solving or diagnosing problems with the step-by-step approach.

Give special emphasis to step 7—**careful consideration of different possibilities.** Encourage students to make a habit of asking themselves, "What are all the possible causes of this problem?" Have them ask questions and do tests to find out which possibilities are most likely. **This process of systematically eliminating different possibilities is basic to the scientific method.**

Special emphasis should also be given to the importance of maintaining 'doubt throughout'. It is best to **never be absolutely sure** of a diagnosis; that would mean closing your mind to the possibility of error. The health worker should always be ready to consider new information and possibilities.



Some of the best chances to practice step-by-step problem solving come during clinical practice and on home visits to sick persons. Instructors can reinforce the students' understanding and use of scientific method by making sure they **always follow the steps systematically.**

The instructor can do much to help students develop a scientific approach to solving problems, both in clinical practice and in role plays. (See Chapter 21.)

The scientific approach to problem solving is especially important for diagnosing and treating health problems. But it has many other applications. If health workers are to help people find their own answers to the problems that most affect their lives, step-by-step problem solving is an essential tool.

For ideas on helping people analyze social problems, see Chapter 26.

SUGGESTIONS FOR HELPING STUDENTS LEARN STEP-BY-STEP SKILLS

Like scientific problem solving, many specific skills or procedures in health care involve a thoughtful, step-by-step approach. Here are suggestions for helping students learn such skills, and for testing to see if they have learned them well.

1. **I do and say—you do and say.**

First, show how to do it. As you demonstrate, **say what you are doing,** step by step.

Then have the student do it. **Have the student also say each step as he does it.**

2. **Mixing up and sorting out the steps.**

To find out if the student has learned a skill well, write the steps on the blackboard in a mixed-up order. For example:

- SMOOTH CAST SURFACE WITH WET HANDS
- SQUEEZE OUT EXTRA WATER
- MAKE SURE BROKEN BONES ARE PROPERLY LINED UP
- CHECK IF CIRCULATION IS GOOD IN LEG
- PUT ON PLENTY OF SOFT PADDING, AVOIDING WRINKLES
- WRAP ON CAST MATERIAL (5 TO 7 LAYERS THICK)
- GET ALL THE SUPPLIES READY
- MAKE SURE THERE ARE NO SHARP EDGES AND CAST IS COMFORTABLE
- PUT ON STOCKINETTE (IF YOU HAVE IT)

Then ask the student to number the steps in the right order. If he can do it correctly, he probably has learned well (although more practice may still be needed).

RECOGNIZING THE HUMAN LIMITATIONS OF SCIENCE

Many people think that scientific knowledge is exact. But much of it is not. Some of what scientists and experts 'know' to be true today, in a few months or years will prove to be false. As our knowledge grows, it changes.

Especially in the science of nutrition, changes in knowledge have been rapid. This can be confusing both for health workers and for those whom they advise.

For example, a few years ago nutritionists placed strong emphasis on giving poorly nourished children more protein. Now we know that most underweight children need more high-energy food rather than more protein. The small amount of protein in their normal diet is usually enough, provided they get plenty of high-energy foods. (See p. **25**-40.)

An angry health worker in Africa complained, "First you told us that our traditional diet, high in energy foods, was not healthy for our children, that they needed more meat and eggs and fish. So we tried to change the traditional diet. Now you tell us what children really need most is more energy foods! What next?!"

Confusion also results when advice that works well in one part of the world is carried elsewhere. For example, some health programs advise giving orange juice to babies as young as 2 months. However, this advice comes from rich countries where many babies drink boiled or *pasteurized* cow's milk. Boiling destroys vitamin C; the orange juice replaces it. But in poor countries where breast feeding is more common, babies get enough vitamin C from breast milk. For these babies, orange juice at 2 months can do more harm than good. Because it is hard to keep it clean when preparing it, orange juice can actually increase the risk of infection. So now we advise mothers to **give babies nothing except breast milk during the first 4 months.**

Situations like this one are bound to come up if a health worker keeps learning and is honest. Role playing will help prepare health workers to deal with these problems in a positive way. Ask some of your students to act out how they might handle a situation like this. Then ask others to comment on how they handled it. (See Chapter 14.)

Every area has examples of advice that later proved inappropriate or was suddenly changed by experts or advisers. Look for local examples and discuss these with fellow instructors and health workers.

It is important that health workers learn how to approach problem solving scientifically. But it is equally important that they recognize and help others to see the human limitations of science. What is 'right' today may be 'wrong' tomorrow.

To make the most of new 'scientific' approaches, it is important that instructors, health workers, and the people they work with learn to:

- Question advice or instructions that come from outside the area (and also advice that comes from inside).
- Try to understand the reasons behind the advice given.
- Modify advice or instructions to fit the local situation.
- When teaching or advising others, admit it openly if you find that advice you have given is wrong or needs to be changed.

It is essential for health workers to develop a critical, questioning attitude—especially when it comes to advice from outsiders.

The need to be honest about mistakes and changes in knowledge

Everyone makes mistakes, including experts, instructors, and health workers. Because our own advisers sometimes change their minds about certain health recommendations, we sometimes find ourselves giving advice that is the opposite of what we have said in the past.

Such situations can be embarrassing. But usually the easiest way to handle them is to be completely honest. Explain to people that you have received new information, and that scientific knowledge is continually growing and changing. That is how we make progress.

By being open and honest about mistakes and changes in knowledge, you as an instructor can set an example for the student health workers.

There is another important reason for discussing changes in scientific knowledge with health workers during training. It helps take some of the magic out of what we teach and are taught. It helps us all to weigh everything new we are told against our own experience. This can be one of the most basic lessons health workers can learn—and teach!

Practice in openly admitting mistakes and explaining changes in advice should be a part of health worker training.

To learn is to question.