Elementary Science

TESS India

Practical investigation: change

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TESS-India OERs have been collaboratively written by Indian and international authors to address Indian curriculum and contexts and are available for online and print use (http://www.tess-india.edu.in/). The OERs are available in several versions, appropriate for each participating Indian state and users are invited to adapt and localise the OERs further to meet local needs and contexts.

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Video resources

Some of the activities in this unit are accompanied by the following icon:  *. This indicates that you will find it helpful to view the TESS-India video resources for the specified pedagogic theme.*

The TESS-India video resources illustrate key pedagogic techniques in a range of classroom contexts in India. We hope they will inspire you to experiment with similar practices. They are intended to complement and enhance your experience of working through the text-based units, but are not integral to them should you be unable to access them.

TESS-India video resources may be viewed online or downloaded from the TESS-India website, http://www.tess-india.edu.in/). Alternatively, you may have access to these videos on a CD or memory card.

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All India - English

What this unit is about

Change is a fundamental concept in understanding the universe and the world we live in. In our day-to-day lives we observe many changes happening. This unit focuses on how you can develop your students' understanding of how change can bring about different effects on the things around us, some of which are permanent and some of which can be reversed. It examines how this can be achieved through practical investigations and how to plan for them. The unit also considers what students learn through practical investigations.

What you can learn in this unit

- How to use practical investigations in your teaching to develop your students' science skills and understanding of the nature of science.
- How to plan and carry out a scientific investigation that develops students' understanding of reversible and irreversible changes.
- How to identify other practical applications of the scientific method in the elementary science classroom.

Why this approach is important

Elementary science is not just about gaining science knowledge, but is also about exploring, discovering, hypothesising and testing ideas. Hands-on learning experience is central to developing your students' scientific skills; it also engages them and communicates the wonder and excitement of science.

It is only by doing practical investigations themselves that students will develop a more scientific understanding of the world around them and begin to understand the nature of science. Your role as a science teacher is to provide opportunities for your students to experience the excitement of carrying out investigations and solving simple problems for themselves.

Practical investigation is important, because it:

- develops students' science skills
- develops their understanding of the nature of science
- supports their learning and understanding of science concepts
- motivates students and develops their curiosity about the world.

Pause for thought

- What does the term 'investigation' mean to you?
- What is involved in an investigation?

1 What are investigations?

Investigations in science are diverse in nature and purpose. Some are closed with a 'correct' answer, while others are open-ended and explorative. Some can be completed in one lesson, whereas others need to be conducted over an extended period of time. They differ in the range of skills required to complete them. Some can be led by the teacher and others can be led by the students themselves.

Common to all investigations is that they start with a period of exploration and subsequently concern a problem or question that needs to be solved or answered. Investigations also involve collecting and analysing evidence in order to answer the question that is being investigated.

Wellington and Ireson (2012) set out a typology of questions for investigations, which is summarised in Table 1.

Table 1 Types of questions according to Wellington and Ireson (2012).

Types of question	Examples
'Which'	Which bag is strongest? Which fabric is the best insulator?
'What'	What happens to the boiling point of water if salt is added? What happens to a compost heap over time?
'How'	How does paper change when it is burned? How is solubility affected by temperature? How much fat is in my diet? How does the quality of water in the river change?

Different types of scientific investigations have been described by Turner (2012). These are summarised in Table 2.

Table 2 Types of investigations according to Turner (2012).

Types of investigation	Examples
Long-term monitoring/observation	How will our compost heap change over time?
Identifying and classifying (includes surveys)	How do people vary in height?
Pattern seeking	Do taller plants grow from bigger seeds? Why do some objects float?
Research (using secondary sources)	How can we tell the time without clocks?
Fair testing (controlling variables)	Which is the strongest bag?

Pause for thought

- Have you included any investigations in your teaching?
- What sort of investigation have you used?
- What do you think your students might gain from doing investigations themselves?

Case Study 1 focuses on how young students can investigate change.

Case Study 1: Experiencing change

Mrs Kama explains how she encouraged her young students to investigate change through the topic of cooking.

I teach 65 Class III students. I was teaching the chapter on cooking. As part of that, I got my students to make roti.

After they had washed their hands, I gave them some flour, salt and oil to mix up. They worked in groups of four to share the mixing. When they all had some dough, I asked them to describe it and whether they would eat it like that. They thought this was very funny.

I asked them what we needed to do to make it into food that they would eat. 'Cook it!' they shouted. So later that day, I cooked them. In the next lesson we looked at how the dough had changed, and we tasted them.

This case study shows how *change* is found in many science topics, and how young students can carry out simple exploratory investigations in a more informal way than would be expected of older students.

Pause for thought

- What other examples of 'change' will students have encountered at home and school?
- How could you extend their experience of changes?

Although younger students would not be expected to use the terms 'reversible' and 'irreversible', they will have come across many examples of such changes, including burning, sieving and separating oil from water.

These experiences can be used when students are introduced to reversible and irreversible changes. By building a repertoire of experiences within their minds, the students can more easily move onto learning about the more abstract concepts.

It is important to provide your students with opportunities to investigate reversible and irreversible change more closely. Through investigations, your students will make links to the everyday experiences they have had already and will be more engaged in their learning. If you ask your students to just read about these changes and the new substances that are formed, the ideas will not be as tangible and the learning will not be as meaningful.

2 Purposes of investigations

As well as being motivating and encouraging positive attitudes towards science, investigations are an important strategy in supporting your students' learning. You might use practical investigations in your teaching for several purposes, including as a means to:

- developing students' skills, e.g. devising a procedure, measuring, observing and data collection, presenting data, or critical evaluation
- supporting students' scientific understanding of a concept, e.g. friction or chemical change
- developing students' understanding of the scientific method, particularly fair testing.

The scientific method involves students in the following:

1. Identifying a question
2. Stating a hypothesis or prediction

3. Identifying the variables
4. Planning the experiment
5. Carrying out the experiment
6. Recording observations
7. Interpreting results
8. Drawing conclusions
9. Presenting the findings.

As the teacher, you need to support your students in thinking and working scientifically. Resource 1 provides ways in which you can help your students. It is not necessary for your students to do all the steps every time you undertake an investigation in your classroom. It is possible to use the scientific method flexibly and focus investigations on one or two aspects at a time depending on your students' experience and ability in doing investigations. So for example, you might focus your teaching on helping the students learn about how to present or interpret their results.

Pause for thought

Which purposes of investigation do you think are most appropriate for the students you teach?

The next case study looks at setting up an investigation.

Case Study 2: Investigating reversible and irreversible changes

Mr Sharma introduces reversible and irreversible changes to his Class VI students. Here he explains how he set up the students' investigation.

I started by asking the students to make objects from pieces of paper by folding it. They made all sorts of objects, such as flowers, aeroplanes and boats. They enjoyed this very much. When they had finished, I told them that the school wanted the paper back and asked whether they could give the sheet of paper back again. The agreed that they could give it back. I told them that this was a reversible change, and wrote it on the blackboard.

Next, I demonstrated burning a piece of paper and asked them what they observed. I wrote their observations on the blackboard. I asked whether this was a reversible change and they said 'No!' I told them that this was an irreversible change, which I wrote on the blackboard.

I then told them that they were going to do a practical investigation into change. I had some materials that they could mix. These included mixing water with salt, flour, plaster of Paris and sand, as well as mixing vinegar with bicarbonate of soda or milk.

They worked in small groups to reduce the resources needed and recorded which substances they mixed and the changes they observed. I used some questions to help them observe the changes. For example, I asked what the original substances looked like compared with the mixture. I asked them if they had seen any bubbles or felt any warmth. I got them to look at texture as well. With each one they had to say whether they thought it was a reversible or irreversible change.

The students enjoyed this investigation very much and mixed lots of substances. Lots of the students could identify the reversible mixtures, but some – like plaster of Paris and water, and salt dissolved in water – they weren't sure about. I kept these mixtures to look at next time.

Pause for thought

- Look back at the questions in Table 1. What questions were the students answering through this investigation?
- What science and social skills did this investigation support?

Practical investigations develop communication, groupwork and scientific skills such as observation, recording, handling materials and equipment, and working safely. Providing opportunities for students to talk whilst carrying out such investigations encourages deeper thinking and better understanding – see Resource 2, 'Talk for learning', for more information about talk in lessons. By getting students to present their findings you can also support the development of their presentation skills and build confidence in speaking to groups.

3 Planning and performing investigations

Whatever the purpose of your investigation, if you want it to be successful then it needs to be planned in advance. You can see Mr Sharma's plan in Resource 3. You will also need to prepare your students for an investigation and support their planning.

Activity 1: Planning a practical investigation

Resource 3 offers some ideas for investigations that you might do in the context of change. You could also plan an investigation in the topic you are teaching. Your plan will need to be suitable for your students' age and ability. The following planning steps provide a guide to the steps you need to go through:

1. What is the purpose of the investigation?
2. What do you want the students to learn by doing the investigation?
3. What equipment and materials will you need?
4. What safety issues need to be considered? What precautions will you take?
5. How will you introduce the investigation?
6. How will you help the students understand what they have to do?
7. How will the students work? In groups? In pairs?
8. What records will students need to make as the investigation proceeds?
9. What questions might you ask as they work?
10. What will you do after the investigation to help you students review their learning?

Video: Planning lessons

http://tinyurl.com/video-planninglessons

Pause for thought

How do you feel about doing an investigation with your students? Excited? Worried? Why is this?

Carrying out a student investigation can seem a bit daunting if you have never done one before. However, your students' enthusiasm and engagement will be a reward for your preparation. If you have a large class, you may need to think differently about how you work with your students so that they can obtain the most from the experience. Using groups may help and perhaps dividing the class into two and working with one half in one lesson and the other half in the next lesson will give you more opportunities to work with the students more closely. This may be most beneficial to those students who need more support with their learning. Once you have taught in this way, you will find that less interactive approaches are not fulfilling for you as a teacher. Read Case Study 3 before you try your investigation.

Case Study 3: Investigating reversible change

Mrs Kama explains how she used an investigation as part of her teaching on reversible change.

I wanted my students to investigate reversible changes. I had lots of ideas about the changes that they could investigate, but it would have taken too much time for them to do them all. So I decided to get them to work in small groups of four and gave them a list of changes to investigate:

- I told them that I needed to make some roti, but that the flour had got grit in it.
- I said I needed some salt, but I had dropped it in water.
- I said I wanted the oil for my lamp, but it was mixed with water.
- I said I wanted to burn some wood for heat, but wanted to get it back afterwards.
- I asked whether I could get my candle back after lighting it.

'Can you help me?' I asked. 'Will you investigate and report back to me?' They were very excited and wanted to help me. Each group could choose two of the investigations and I made sure all were done by at least one group. To help them plan their investigation, I gave them some questions to think about. These were:

- How will you try to separate the mixture?
- What apparatus will you need?
- What procedure will you follow?
- What will you observe?
- What will you record?
- How will you report your findings?
- What will each member of your group do?

I told them that they could ask an expert scientist called Doctor Know-A-Lot to help them if they needed it. I played the part of Doctor Know-A-Lot and as they talked and planned, I encouraged them to write their plan and asked questions about what they planned to do.

When they were ready, they collected their materials and carried out their plans. I went around as Doctor Know-A-Lot to make sure they were working safely and making observations.

It was interesting to see the different approaches that the groups took. For example, one group separated the oil and water by carefully pouring the oil off, while another group heated it to evaporate the water off. Another group left the salt water in a shallow dish in the sun, but another group tried to filter the salt out.

In the next lesson, we discussed what methods they had used to separate the mixtures, which ones were most successful and why, and which changes were not reversible and why. The students wrote their reports for me. I could tell they enjoyed the activity because they did some of their best work. I was so glad I did this investigation rather than just a paper and pencil exercise from the book, because it really captured their interest.

Pause for thought

Referring again to Table 1, what type of investigation(s) were the students asked to do? What do you think contributed to the success of Mrs Kama's approach to the investigation? What ideas would you use in your own teaching? Check your plan from Activity 1 and make changes if you want to.

Did you notice that Mrs Kama set the investigation in a problem solving context? She did not simply ask the students to investigate how to separate the mixtures – instead, she made it part of a story that had a purpose. When you are planning your own investigations, think about the context that you could set it in. It might be a problem to solve, such as getting salt from sea water or preventing nails rusting. Or you might put the students in the role of scientists tasked with making a recommendation – asking which insulator is the best, for example.

Activity 2: Using an investigation in your teaching

You are now going to teach your investigation lesson with your class.

Resource 4, 'Planning lessons', gives advice to help you do this activity, and Resource 5 gives some ideas for investigations that you might do in the context of change. Introduce the investigation, relating it to what has been covered previously. Explain the purpose of the investigation to the class.

As the students work on the investigation, go around the classroom and check what they are doing. Ask questions to find out their ideas and support them. Make sure that you support those students who have more difficulty with learning. You can do this in many ways, such as, for example, grouping them together and working with them to aid their discussions, or giving them a simpler task.

Once the investigation lesson has been completed, think about and make notes on the following questions:

- What type of investigation did your students do?
- What planning was needed to prepare the investigation?
- What went well with your lesson?
- How did the students respond to the investigation?
- What do you think your students learnt from doing the investigation? How do you know this?
- What could have been improved? How would you change it?
- Which students did well and which may need more support? How do you know this?

Practical investigations are an important part of the elementary science curriculum and are fundamental to learning about science. They can be used across all ages and science topics, and serve a variety of purposes. They provide opportunities for students to be involved. You can use investigations regularly in your teaching to improve your students' science skills and understanding.

Video: Involving all

http://tinyurl.com/video-involvingall

4 Summary

Elementary students will only develop their scientific investigation skills by 'doing' science. As a teacher you need to provide opportunities for students of all ages to carry out open-ended investigations that are meaningful and relate to their life experiences. It is only through practical investigation that your students will develop essential thinking skills that will enable them to understand the scientific process.

This unit has explored how young students can conduct investigations with the support of their teachers. With appropriate teacher support, your elementary level students are capable of asking questions, making observations, predicting outcomes, carrying out practical investigations, recording information, interpreting data, drawing conclusions and reporting findings. Incorporating investigations into their learning will increase your students' enjoyment of science, improve their skills and contribute to the development of their complex critical thinking for the future.

Students also need feedback on how well they are doing and where they could improve their skills. This needs to be given in ways that students find useful and help them make progress, otherwise they will ignore the feedback. (For more details, you may want to read the key resource 'Monitoring and giving feedback' (http://tinyurl.com/kr-monitoringandfeedback)).

Resources

Resource 1: The scientific method in the classroom

The basic steps of the scientific method can be introduced and used with students from a young age. The list below discusses some of the ways that the scientific method can be applied in the everyday science classroom.

1 Question/problem

Questions drive the scientific method. As students begin to explore a new concept or topic, they will ask questions. Some of these questions can be used as a basis for investigation, such as 'Where does the salt go when it dissolves?' or 'What happens when a candle burns?' Students may produce questions like these during a brainstorming session or they could be encouraged to generate questions by completing a statement such as 'I wonder …'.

2 Observation/research

The opportunities to promote observation skills in the school environment are almost limitless. For example, by planting different types of seeds in pots, students can observe the plant life cycle directly themselves. By standing outside, students can observe how shadows are cast. By looking inside their own mouth, and those of other students, students can observe the similarities and differences between people's teeth.

3 Form a hypothesis

You should use open-ended questions to encourage students to make a prediction. Examples might include 'What do you think has happened to the salt?' or 'What will happen to the candle when we burn it?' This kind of questioning will inspire students to find answers.

4 Conduct an experiment

Student-driven investigations that are based on questions that the students have generated themselves will be more motivating and meaningful to them. You can provide students with simple equipment to create

their own investigations. Your students can provide oral feedback about what they have noticed or can draw and label what they have observed.

5 Collect results

Recording and collecting data is fundamental to the scientific method, with data students would not be able to draw conclusions about the way the world works around them. Data can be collected and represented in a variety of ways such as, graphs, tables, sketches, photos, videos and journals.

6 Conclusion

It is preferable for students to draw their own conclusions rather than be provided with answers by their teacher. You can help your students to construct their own meaning by asking them carefully worded open-ended questions. Examples might include 'Why do you think the coin sinks and the straw floats?' or 'Why does your heart beat quickly when you jump for one minute?' Allowing students to develop their own ideas can lead to further questions and investigations!

7 Communicate the results

Students should be given opportunities to discuss what they have noticed with their teachers and peers. This will help them to make connections between cause and effect, and help to organise their thinking.

Resource 2: Talk for learning

Why talk for learning is important

Talk is a part of human development that helps us to think, learn and make sense of the world. People use language as a tool for developing reasoning, knowledge and understanding. Therefore, encouraging students to talk as part of their learning experiences will mean that their educational progress is enhanced. Talking about the ideas being learnt means that:

- those ideas are explored
- reasoning is developed and organised
- as such, students learn more.

In a classroom there are different ways to use student talk, ranging from rote repetition to higher-order discussions.

Traditionally, teacher talk was dominant and was more valued than students' talk or knowledge. However, using talk for learning involves planning lessons so that students can talk more and learn more in a way that makes connections with their prior experience. It is much more than a question and answer session between the teacher and their students, in that the students' own language, ideas, reasoning and interests are given more time. Most of us want to talk to someone about a difficult issue or in order to find out something, and teachers can build on this instinct with well-planned activities.

Planning talk for learning activities in the classroom

Planning talking activities is not just for literacy and vocabulary lessons; it is also part of planning mathematics and science work and other topics. It can be planned into whole class, pair or groupwork, outdoor activities, role play-based activities, writing, reading, practical investigations, and creative work.

Even young students with limited literacy and numeracy skills can demonstrate higher-order thinking skills if the task is designed to build on their prior experience and is enjoyable. For example, students can make

predictions about a story, an animal or a shape from photos, drawings or real objects. Students can list suggestions and possible solutions about problems to a puppet or character in a role play.

Plan the lesson around what you want the students to learn and think about, as well as what type of talk you want students to develop. Some types of talk are exploratory, for example: 'What could happen next?', 'Have we seen this before?', 'What could this be?' or 'Why do you think that is?' Other types of talk are more analytical, for example weighing up ideas, evidence or suggestions.

Try to make it interesting, enjoyable and possible for all students to participate in dialogue. Students need to be comfortable and feel safe in expressing views and exploring ideas without fear of ridicule or being made to feel they are getting it wrong.

Building on students' talk

Talk for learning gives teachers opportunities to:

- listen to what students say
- appreciate and build on students' ideas
- encourage the students to take it further.

Not all responses have to be written or formally assessed, because developing ideas through talk is a valuable part of learning. You should use their experiences and ideas as much as possible to make their learning feel relevant. The best student talk is exploratory, which means that the students explore and challenge one another's ideas so that they can become confident about their responses. Groups talking together should be encouraged not to just accept an answer, whoever gives it. You can model challenging thinking in a whole class setting through your use of probing questions like 'Why?', 'How did you decide that?' or 'Can you see any problems with that solution?' You can walk around the classroom listening to groups of students and extending their thinking by asking such questions.

Your students will be encouraged if their talk, ideas and experiences are valued and appreciated. Praise your students for their behaviour when talking, listening carefully, questioning one another, and learning not to interrupt. Be aware of members of the class who are marginalised and think about how you can ensure that they are included. It may take some time to establish ways of working that allow all students to participate fully.

Encourage students to ask questions themselves

Develop a climate in your classroom where good challenging questions are asked and where students' ideas are respected and praised. Students will not ask questions if they are afraid of how they will be received or if they think their ideas are not valued. Inviting students to ask the questions encourages them to show curiosity, asks them to think in a different way about their learning and helps you to understand their point of view.

You could plan some regular group or pair work, or perhaps a 'student question time' so that students can raise queries or ask for clarification. You could:

- entitle a section of your lesson 'Hands up if you have a question'
- put a student in the hot-seat and encourage the other students to question that student as if they were a character, e.g. Pythagoras or Mirabai
- play a 'Tell Me More' game in pairs or small groups
- give students a question grid with who/what/where/when/why questions to practise basic enquiry

- give the students some data (such as the data available from the World Data Bank, e.g. the percentage of children in full-time education or exclusive breastfeeding rates for different countries), and ask them to think of questions you could ask about this data
- design a question wall listing the students' questions of the week.

You may be pleasantly surprised at the level of interest and thinking that you see when students are freer to ask and answer questions that come from them. As students learn how to communicate more clearly and accurately, they not only increase their oral and written vocabulary, but they also develop new knowledge and skills.

Resource 3: Mr Sharma's plan for an investigation

Table R3.1 Mr Sharma's plan for an investigation.

Purpose of investigation	To develop investigation skills and support students understanding of change
Learning objectives	By the end of the investigation the students will be able to: • identify different changes that occur when substances are mixed • use observations to predict reversible and irreversible changes.
Resources needed	Pieces of paper, water, salt, flour, plaster of Paris, sand, vinegar, bicarbonate of soda, milk, containers for mixing
Safety	Make sure substances don't go in students' eyes.
Plan of demonstration	
Introduction	Students make objects by folding paper. How has the paper changed? Tell students paper needed back – can they reverse the change? Show burning paper. Write students' observation on the chalkboard. Can it be reversed? Write 'reversible' and 'irreversible' on chalkboard.
Setting up investigation	Tell students they are going to investigate changes when substances are mixed and decide whether they are reversible or irreversible. Investigation questions: 'What happens when substances are mixed?' 'Which changes are reversible?' Ask students to work in groups. They have one small container and collect substances and mix and observe. Waste in bucket. Draw results table on board. Students copy in to books to complete as they investigate.

<table>
<tr><td></td><td>
<table>
<tr><th>Substances</th><th>Observations</th><th>Reversible or not?</th></tr>
<tr><td>Water and salt</td><td></td><td></td></tr>
<tr><td>Water and plaster</td><td></td><td></td></tr>
<tr><td>Water and flour</td><td></td><td></td></tr>
<tr><td>Water and sand</td><td></td><td></td></tr>
<tr><td>Milk and vinegar</td><td></td><td></td></tr>
<tr><td>Vinegar and bicarbonate of soda</td><td></td><td></td></tr>
<tr><td>Sand and flour</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>During investigation</td><td>Go round and help students make observations by using questions. Make sure they are not using too much of each substance.</td></tr>
<tr><td>After investigation</td><td>Whole class – ask what they observed – complete table on board. Which mixtures do they think are reversible? Why? How would they reverse them?</td></tr>
</table>

Resource 4: Planning lessons

Why planning and preparing are important

Good lessons have to be planned. Planning helps to make your lessons clear and well-timed, meaning that students can be active and interested. Effective planning also includes some in-built flexibility so that teachers can respond to what they find out about their students' learning as they teach. Working on a plan for a series of lessons involves knowing the students and their prior learning, what it means to progress through the curriculum, and finding the best resources and activities to help students learn.

Planning is a continual process to help you prepare both individual lessons as well as series of lessons, each one building on the last. The stages of lesson planning are:

- being clear about what your students need in order to make progress
- deciding how you are going to teach in a way that students will understand and how to maintain flexibility to respond to what you find
- looking back on how well the lesson went and what your students have learnt in order to plan for the future.

Planning a series of lessons

When you are following a curriculum, the first part of planning is working out how best to break up subjects and topics in the curriculum into sections or chunks. You need to consider the time available as well as ways for students to make progress and build up skills and knowledge gradually. Your experience or discussions with colleagues may tell you that one topic will take up four lessons, but another topic will only take two.

You may be aware that you will want to return to that learning in different ways and at different times in future lessons, when other topics are covered or the subject is extended.

In all lesson plans you will need to be clear about:

- what you want the students to learn
- how you will introduce that learning
- what students will have to do and why.

You will want to make learning active and interesting so that students feel comfortable and curious. Consider what the students will be asked to do across the series of lessons so that you build in variety and interest, but also flexibility. Plan how you can check your students' understanding as they progress through the series of lessons. Be prepared to be flexible if some areas take longer or are grasped quickly.

Preparing individual lessons

After you have planned the series of lessons, each individual lesson will have to be planned **based on the progress that students have made up to that point**. You know what the students should have learnt or should be able to do at the end of the series of lessons, but you may have needed to re-cap something unexpected or move on more quickly. Therefore each individual lesson must be planned so that all your students make progress and feel successful and included.

Within the lesson plan you should make sure that there is enough time for each of the activities and that any resources are ready, such as those for practical work or active groupwork. As part of planning materials for large classes you may need to plan different questions and activities for different groups.

When you are teaching new topics, you may need to make time to practise and talk through the ideas with other teachers so that you are confident.

Think of preparing your lessons in three parts. These parts are discussed below.

1 The introduction

At the start of a lesson, explain to the students what they will learn and do, so that everyone knows what is expected of them. Get the students interested in what they are about to learn by allowing them to share what they know already.

2 The main part of the lesson

Outline the content based on what students already know. You may decide to use local resources, new information or active methods including groupwork or problem solving. Identify the resources to use and the way that you will make use of your classroom space. Using a variety of activities, resources, and timings is an important part of lesson planning. If you use various methods and activities, you will reach more students, because they will learn in different ways.

3 The end of the lesson to check on learning

Always allow time (either during or at the end of the lesson) to find out how much progress has been made. Checking does not always mean a test. Usually it will be quick and on the spot – such as planned questions or observing students presenting what they have learnt – but you must plan to be flexible and to make changes according to what you find out from the students' responses.

A good way to end the lesson can be to return to the goals at the start and allowing time for the students to tell each other and you about their progress with that learning. Listening to the students will make sure you know what to plan for the next lesson.

Reviewing lessons

Look back over each lesson and keep a record of what you did, what your students learnt, what resources were used and how well it went so that you can make improvements or adjustments to your plans for subsequent lessons. For example, you may decide to:

- change or vary the activities
- prepare a range of open and closed questions
- have a follow-up session with students who need extra support.

Think about what you could have planned or done even better to help students learn.

Your lesson plans will inevitably change as you go through each lesson, because you cannot predict everything that will happen. Good planning will mean that you know what learning you want to happen and therefore you will be ready to respond flexibly to what you find out about your students' actual learning.

Resource 5: Some ideas for investigations in the context of change

1. How much salt will dissolve in a cup of water?
2. Which is most soluble, salt or sugar?
3. How is the solubility of salt (or sugar) affected by temperature?
4. Which sort of paper absorbs the most water?
5. Which lasts the longest, a fat candle or a thin candle?

Additional resources

- Primary science investigation: http://oer.educ.cam.ac.uk/wiki/Primary_Science_investigation
- Investigative skills: http://www.ase.org.uk/resources/scitutors/subject-knowledge/k12-investigative-skills/

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