Scientific research and scientific ethics

Lesson plan and teacher's notes · Form 2 Biology · 1 period of 40 minutes

School	(write school name)	**Teacher**	(write name)
Date	(date)	**Class**	Form 2
Subject	Biology	**Enrolment**	Boys ___ Girls ___ Total ___
Time	40 minutes	**Topic**	Scientific research and scientific ethics

Learners say what scientific research is, tell it apart from guessing, explain the main principles of scientific ethics, judge research stories as ethical or unethical with reasons, and say why science cannot answer every question about life. The lesson uses a school garden investigation and short role-play stories.

Specific outcomes

By the end of the lesson, learners should be able to:

1. Say what scientific research is and give an example
2. Tell scientific research apart from guessing
3. Explain the main principles of scientific ethics
4. Judge whether a research story is ethical or unethical and give reasons, and say why science cannot answer every question about life

Prior knowledge

- Observing and recording in a science lesson
- Plants need sunlight, water and soil to grow
- Respecting other people's information

Teaching and learning materials

- chalk and board
- exercise books
- cards with short research stories
- pencils

References

Ministry of Education (CDC) Form 2 Biology syllabus and module; 25Schools learners' note: Scientific research and scientific ethics.

Lesson development

Stage and time	Teacher activities	Learner activities
Introduction 5 min	Ask how a learner could find out if sunlight affects plant growth in the school garden. Write scientific research on the board with its meaning.	Suggest ways to find out and copy the meaning.
Development: scientific research 10 min	Show the steps: ask a clear question, collect evidence by observing and experimenting, draw a conclusion. Show that guessing without testing is not research.	Sort four statements into scientific research or not.
Development: scientific ethics 12 min	Explain ethics and give the principles: honesty, integrity, objectivity, responsibility, informed consent and confidentiality. Explain bias.	Match each principle with its meaning and give one example of each.
Development: judging stories 10 min	Use the key question: which principle is being kept or broken? Work the falsified plant growth case and the health questions case.	In groups, judge two story cards as ethical or unethical and give reasons.
Conclusion 3 min	Ask why science cannot answer every question about life. Set the homework.	Answer and copy the homework.

Teacher's content notes

Read these before the lesson. They are what you need to know, not what to copy onto the board.

What scientific research is

Scientific research is an investigation carried out to discover new knowledge or to verify existing knowledge. A researcher asks a clear question, collects evidence by observing and experimenting, and draws a conclusion from that evidence. For example, you can investigate how sunlight affects plant growth. Guessing which plant will grow faster without testing, or saying plants grow better in rain without collecting any data, is not scientific research.

Scientific ethics and its principles

Ethics are rules or standards that help us tell right behaviour from wrong behaviour. Scientific ethics are the moral principles and rules that guide how scientific work should be done. They protect people, animals and the environment, and they keep scientific information accurate and trustworthy. Honesty means reporting data as it truly is. Integrity means doing the right thing even when no one is watching. Objectivity means using evidence, not personal feelings, so that bias does not spoil the results. Responsibility means thinking about how the work affects people, animals and the environme

Judging a research story

To judge a research story, ask which principle is being kept or broken. A learner who changes results to make an experiment look successful breaks honesty and is unethical. A safe and honest investigation records what truly happens, even when the result is not what was expected, and protects everyone taking part.

The limits of science

Science is a powerful tool for understanding the natural world and can be applied to solve practical problems. However, it does not answer every question about life. Other sources of knowledge, such as culture, experience and personal values, also matter, and recognising the limits of science helps us respect them.

Questions to ask during the lesson

Question	Expected answer
A learner wants to find out how sunlight affects plant growth in the school garden. (a) Say what scientific research is. (b) Name the steps she should follow. (c) Say how this is different from guessing.	(a) An investigation to discover new knowledge or to verify existing knowledge. (b) Ask a clear question, collect evidence by observing and experimenting, draw a conclusion. (c) Guessing has no testing or data.
A group of learners is told to report data as it truly is even when they do not like it. (a) Name the principle. (b) Name the principle of doing the right thing even when nobody is watching. (c) Name the principle of using evidence rather than feelings.	(a) Honesty. (b) Integrity. (c) Objectivity.
A researcher wants to ask learners about their health for a project. (a) Say what informed consent means. (b) Say what confidentiality means. (c) Say what bias is.	(a) Permission given after being fully told about the research. (b) Protecting personal information from being shared without permission. (c) An unfair influence that affects the results or conclusions.
A learner thinks science can answer every question about life. (a) Say whether this is true. (b) Name two other sources of knowledge. (c) Say what recognising the limits of science helps us do.	(a) No. (b) For example culture, experience and personal values. (c) Respect these other sources of knowledge.

Worked examples for the board

Example 1: health questions read aloud

A learner asks classmates about their health for a project and then reads the names and answers aloud to the whole school. Which principles are broken? The learner shared personal information without permission, which breaks confidentiality. If the classmates were not told how their answers would be used, informed consent was also missing. So the project is unethical.

Example 2: falsified results

A learner investigates plant growth but changes the results to make the experiment look successful. That breaks honesty, because the data is falsified. It also misleads anyone who later uses the results. So it is unethical.

Example 3: an honest investigation

A learner records what truly happens, even when the result is not what was expected, and protects everyone taking part. This keeps honesty and responsibility, so the investigation is ethical.

Board plan

Write the title. Left: the steps of scientific research. Centre: the table of principles with their meanings. Right: the key question for judging a story and the two worked cases.

Principle	What it means
Honesty	Reporting data as it truly is
Integrity	Doing the right thing even when no one is watching
Objectivity	Using evidence, not personal feelings, so bias does not spoil the results
Responsibility	Thinking about how the work affects people, animals and the environment
Informed consent	Participants agree only after they are fully informed
Confidentiality	Participants' personal information is protected

Principles of scientific ethics

Mistakes to expect

Learners often think	Put it right
Guessing which plant will grow faster is scientific research.	Guessing without testing is not research. Research collects evidence by observing and experimenting and draws a conclusion from it.
If the result is not what was expected, the data should be changed.	Changing results breaks honesty. An honest investigation records what truly happens even when the result is not what was expected.
Science can answer every question about life.	Science is powerful, but other sources of knowledge, such as culture, experience and personal values, also matter.
Ethics only matter when someone is watching.	Integrity means doing the right thing even when no one is watching.

Differentiation

Learners who struggle

Give learners a card with the six principles and their meanings, and the key question. Read each story card aloud with the group before they judge it.

Learners who finish early

Ask learners who finish early to write a short story of their own in which one principle is broken, and exchange it with a partner who names the principle and gives the reason.

Hearing or visual impairment

For learners with hearing impairment, write each principle and story on the board and use gestures for the key ideas. For learners with visual impairment, read each story card aloud slowly and let learners answer orally.

No projector, no printing

Write the story cards on the board or read them aloud. No equipment is needed except exercise books. Use a school garden or a few potted plants for the sunlight example.

If time is short

Teach scientific research and the principles of scientific ethics. Leave judging stories and the limits of science for the next lesson.

Evaluation

Question or task	A correct answer shows
A learner investigates plant growth in the school garden but changes the results so that the experiment looks successful. (a) Say which principle is broken. (b) Explain why the data is wrong for others who use it. (c) Say whether the work is ethical or unethical.	(a) Honesty, because the data is falsified. (b) It misleads anyone who later uses the results. (c) Unethical.
A learner asks classmates about their health for a project and then reads the names and answers aloud to the whole school, and the classmates were not told how the answers would be used. (a) Name the principle broken when names are read aloud. (b) Name the second principle broken. (c) Say whether the project is ethical.	(a) Confidentiality, because personal information was shared without permission. (b) Informed consent. (c) Unethical.
A learner says that plants grow better in rain without collecting any data and another measures the height of plants in sun and shade for four weeks. (a) Say who is doing scientific research. (b) Give the reason. (c) Name the three steps of research.	(a) The learner who measures. (b) Evidence is collected by observing and measuring. (c) Ask a clear question, collect evidence, draw a conclusion.

Homework

A class plans a project to find out how many insects live in the school garden. (a) Say how the learners could keep the project honest. (b) Say how they could protect the garden. (c)

Say one question about life that science cannot fully answer and why other knowledge matters.

Extra practice with answers

Question	Answer
1. A learner says the sun makes plants grow better because she thinks so but she has not tested it. (a) Say whether this is scientific research. (b) Give the reason. (c) Say what she should do to make it research.	(a) No. (b) No evidence was collected. (c) Observe and experiment, collect data and draw a conclusion from the evidence.
2. A learner invents results because the real results did not show what she expected. (a) Name the principle broken. (b) Say why it is a problem for others. (c) Say what an honest learner would do.	(a) Honesty. (b) It misleads anyone who later uses the results. (c) Record what truly happens.
3. A researcher publishes the names and test scores of the learners who took part without asking them. (a) Name the principle broken. (b) Name a second principle that may also be broken. (c) Say whether the research is ethical.	(a) Confidentiality. (b) Informed consent. (c) Unethical.
4. A learner always chooses the result that pleases her friend instead of the evidence. (a) Name what is affecting the results. (b) Name the principle that is broken. (c) Say what she should use instead.	(a) Bias. (b) Objectivity. (c) Evidence.
5. An elder says that some questions about life are answered by culture and personal values, not by experiments. (a) Say whether science answers every question about life. (b) Say why other sources of knowledge matter. (c) Name two other sources.	(a) No. (b) Recognising the limits of science helps us respect them. (c) For example culture, experience and personal values.

Answers to the learners' check-yourself questions

1. What is scientific research?
   An investigation carried out to discover new knowledge or to verify existing knowledge, using evidence.
2. What does informed consent mean?
   Permission given by participants after they have been fully told about the research.
3. What is bias?
   An unfair influence that affects the results or conclusions of research.
4. Why is guessing which plant will grow faster, without testing, not scientific research?
   Nothing is tested and no evidence is collected.
5. Name two principles of scientific ethics and say what each one means.
   For example honesty (reporting data truthfully without falsifying it) and confidentiality (protecting participants' personal information).

6. You are a learner at a school in Luangwa. You grow beans for a class project and, to get a better mark, you write down that all your plants grew tall although two plants died. (a) Which principle of scientific ethics have you broken? (b) Explain why this makes the project unethical. (c) Say what you
   (a) Honesty, because the data was falsified. (b) The results no longer show what truly happened, so they cannot be trusted. (c) Record all the results truthfully, including the dead plants, and report them.
7. A group of learners wants to ask pupils in other classes about their eating habits for a project. They plan to write each pupil's name next to their answers and put the list on the notice board. (a) Which two principles are at risk? (b) Say what the group should do before they start. (c) Explain why
   (a) Confidentiality and informed consent. (b) Explain the project to the pupils, ask for their permission, and keep names private. (c) It stops personal information from being shared and respects each pupil's choice.

Teacher's reflection

What went well:

What I will change next time:

Learners who need follow-up: