RAISING QUESTIONS

STUDENTS OBSERVE PHENOMENA TO GENERATE INVESTIGABLE QUESTIONS

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SUITABLE FOR AGE(S)	SUBJECT(S)	KEY FOCUS
6-18 years	All subjects	Generating questions

INTRODUCTION

Asking questions is a core scientific skill. This task engages learners in exploring how questions can be classified as investigable or non-investigable and teaches them to transform non-investigable questions into investigable ones by identifying variables.

The activity requires no prior knowledge and focuses on the scientific practice of questioning (Council, 2012). It is adaptable across all educational levels and even benefits trained scientists by clarifying effective questioning strategies.

Although young children are naturally curious, the ability to ask questions tends to decline with age and schooling, not necessarily due to education itself, but because educational systems often prioritise answering over questioning (Janssen, 2008). Since skilled questioning is at the heart of scientific discovery, this practice should be intentionally cultivated in science and mathematics education.

TASK DESCRIPTION

Through hands-on observation of an everyday phenomenon, learners generate questions, categorise them, and learn techniques to convert non-investigable questions into investigable ones. The task consists of a five-step interactive workshop:

1. Observation and questioning
2. Reflection on types of questions
3. Classification of questions
4. Reframing questions using variable scanning
5. Exit reflection

Learners engage deeply with a chosen phenomenon and collaborate to refine their questioning and inquiry skills.

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TASK PREPARATION

Select an observable phenomenon that sparks curiosity and allows for varied observations e.g. ice balloon, gel balls (https://en.wikipedia.org/wiki/Water_gel_(plain)), closed ecosystem, burning flame, dancing raisins (https://www.youtube.com/watch?v=mEGCvj977_A&frags=pl%2Cwn).

Have one phenomenon setup per group (3–4 learners).

Materials needed:

- A selected phenomenon (ice balloon, gel balls, burning flame, dancing raisins, etc.)
- Post-it notes or white paper (minimum 10 per group)
- Observation tools: (magnifying glasses, thermometers, light sources)
- Blackboard or whiteboard
- Writing materials (pens, markers)
- Exit ticket slips

TASK IMPLEMENTATION

Step 1: Observation and Asking Questions (15 min)

Learners work in groups of 3–4. They observe the phenomenon, first using only sight, and then with other senses or tools. For First 5 minutes, learners make observations using sight only. For next 10 minutes, learners make observations using additional senses (touch, smell, …) and tools (e.g. magnifying glasses, thermometers, extra light). Each group writes at least 10 questions (1 per slip of paper). Creativity is encouraged; no "wrong" questions. Stimulate participants to think out of the box.

Step 2: Reflection of the Activity (10 min)

In this activity, groups reflect on the previous activity.

Facilitated discussion prompts:

- Was it easy? Why or why not?
- Was there a difference between using only your eyes and using other senses or instruments?
- Are there different types of questions in your group?
- Are there any questions for which you know the answer?
- Are there many questions for which you do not know the answer?

Each group identifies their most original question and shares it with the class. A class discussion on conditions for formulating new questions follows.

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The facilitator writes the most original questions on the blackboard, allowing learners to see different types of questions.

Step 3: Investigable and Non-Investigable Questions (20 min)

Groups sort their questions into two categories (10 min):

- Investigable questions: Answerable through concrete experimentation with available materials.
- Non-investigable questions: Not directly answerable through classroom experimentation. This can be due to the lack of equipment in the classroom, lack of time, or because it cannot be investigated experimentally due to the nature of the question.

After 10 minutes, the class discusses what makes a question investigable versus non-investigable.

Questions that lead to an action are considered "investigable." For example, questions that begin with "what will happen if" … or contain the phrase "what is the influence of a certain parameter on the phenomenon" can be investigated. The way they are phrased invites one to experiment with materials and phenomena. "What will happen if we put salt on the ice?" or "Does the temperature of the water make a difference?" indicate a clear course of action. Those questions relate to searching for patterns that result from direct observation.

Conversely, questions that do not lead to taking hands-on action are considered "non-investigable." For example, questions that begin with why—such as "Why is most of the ice balloon underneath the water?" or "Why are parts of the ice balloon cloudy?" are non-investigable. They are stated in a way that does not lead directly to hands-on action that would help to answer the stated question. Instead, they are requests for information or explanations. Answering these kinds of questions usually requires obtaining information from a book, the Internet or a person with experience in the area. Those types of questions require models to find an answer.

Facilitated class discussion explores:

- Characteristics of investigable vs. non-investigable questions.
- How phrasing influences whether a question leads to action.

Step 4: Turning Non-Investigable Questions into Investigable Ones (20 min)

In this step, learners use the variable scan technique to:

- Identify variables that can be manipulated.
- Practice reformulating "why" questions into testable "what if" or "how does" questions.

Groups work collaboratively to reframe at least one question using variable scanning. Class discussion reinforces this skill.

Introduction to the variable scan technique:

The way a question is framed affects how it can be answered. The technique to turn non-investigable questions into investigable ones, is called a variables scan. When you know the variables of the phenomenon, you can easily reformulate non-investigable questions into questions that can lead to experimental action.

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Take the following situation: some learners are exploring how paper towels absorb water. They notice that paper towels seem to "suck up" the water. Someone asks, "Why does the water go into the paper towel?" If we want to turn this question into an investigable question, you need to scan the phenomenon for variables. The explanation must have something to do with how the water and the paper towel interact, so those are the variables we can change to help us learn more about the phenomenon.

Now, consider variable one: the liquid being absorbed and ask yourself the question, 'What could be changed about the liquid?' The kind of liquid (orange juice, motor oil, etc.) or the amount of liquid or the temperature of the liquid. Immediately, you can produce several investigable questions, turning the original question: "Why does the water go into the paper towel?" into 'Would something different happen if the water were very hot or very cold?' or 'Would salt water result in a different outcome from fresh water?' or 'Will the water be sucked higher into the paper if we used tomato juice instead of water?'

Consider the next variable: the material absorbing the liquid. What could be changed about the paper towel? The brand of paper towel, the way of wetting the towel (pouring the water onto the paper, dipping the towel into the water, etc.), and the kind of material (cotton, wool, cardboard, etc.).

Learners use this information to create some extra investigable questions. Investigating the relevant variables (like the quality of the paper or the viscosity of the liquid) may lead to a deeper understanding of the mechanisms behind the absorption of water in tissues.

After this example, the learners get the opportunity to practice the skill of reformulating non-investigable questions into questions that can lead to action.

Facilitating Prompt:

'Take a why question from your group or from another group and turn it into an investigable question'.

Step 5: Exit Ticket (5 min)

Each learner writes an exit ticket to answer:

- What are your main takeaways from this task?
- How practical is this approach for your own learning?
- Formulate one question or an alternative idea inspired by the activity

KEY LEARNINGS

This task was tested with students, pre-service teachers, and in-service teachers. Key learnings from its implementation include:

- When the learners have not much experience with science topics, most of the questions in the first step are why questions.

- The more experienced the learners are, the more investigable questions are made.
- There are no wrong questions. Non-investigable questions (often Why questions) often can serve as the starting point for scientific inquiry. That is why it is important to train learners to rephrase non-investigable questions to investigable ones.

CONCLUSION

This workshop focuses on an important scientific practice: asking questions (Council, 2012). It represents only the first step in training this inquiry skill. While this workshop serves as an introduction, the practice of asking questions and transforming non-investigable questions into investigable ones should become a regular part of science teaching.

This activity trains learners to inquire more deeply about daily-life phenomena and helps them transition from everyday curiosity to real scientific inquiry.

REFERENCES

This workshop is based on a workshop developed in the Exploratorium in San Francisco.

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