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Key Elements for Designing Inquiry-Based Learning Units

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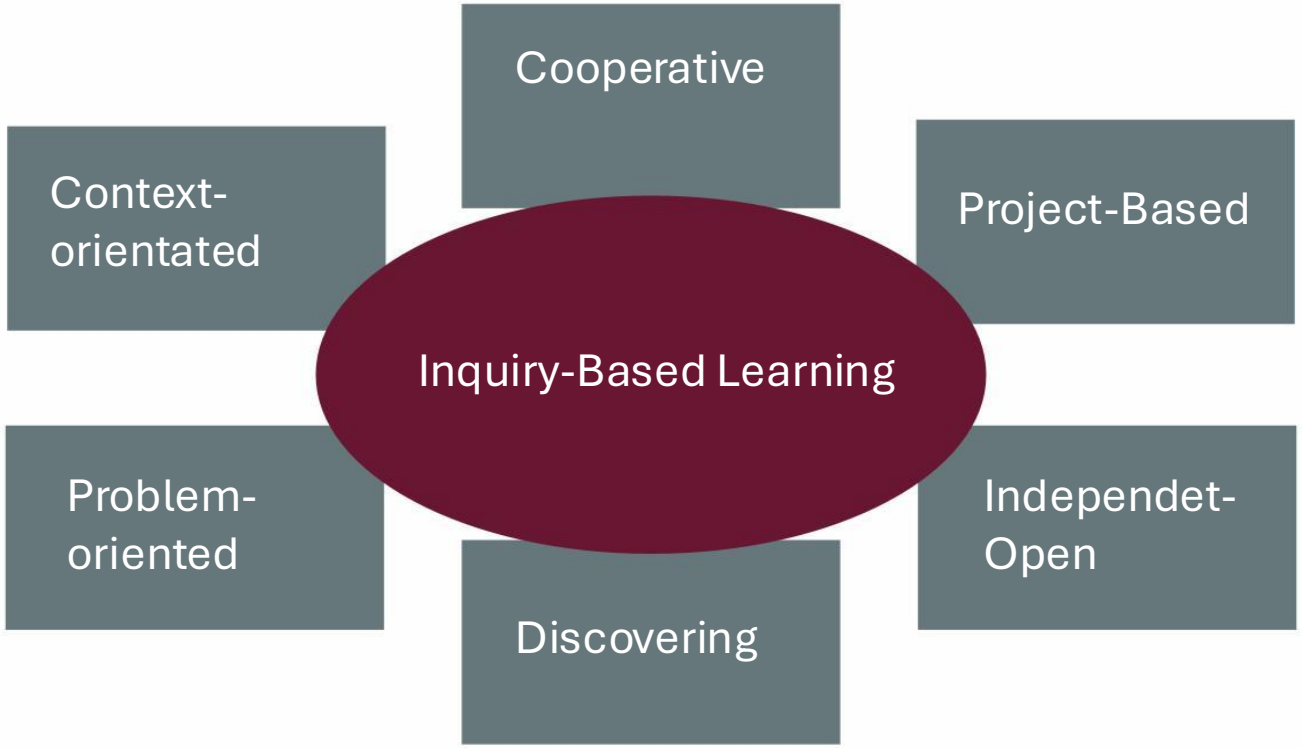
INQUIRY-BASED LEARNING
AS AN OVERARCHING TEACHING APPROACH



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Definition of term: Inquiry-based Learning

"... activities of students in which they develop knowledge and understanding of scientific ideas, as well as an understanding of how scientists study the natural world."

(National Research Council, 1996, S. 23)

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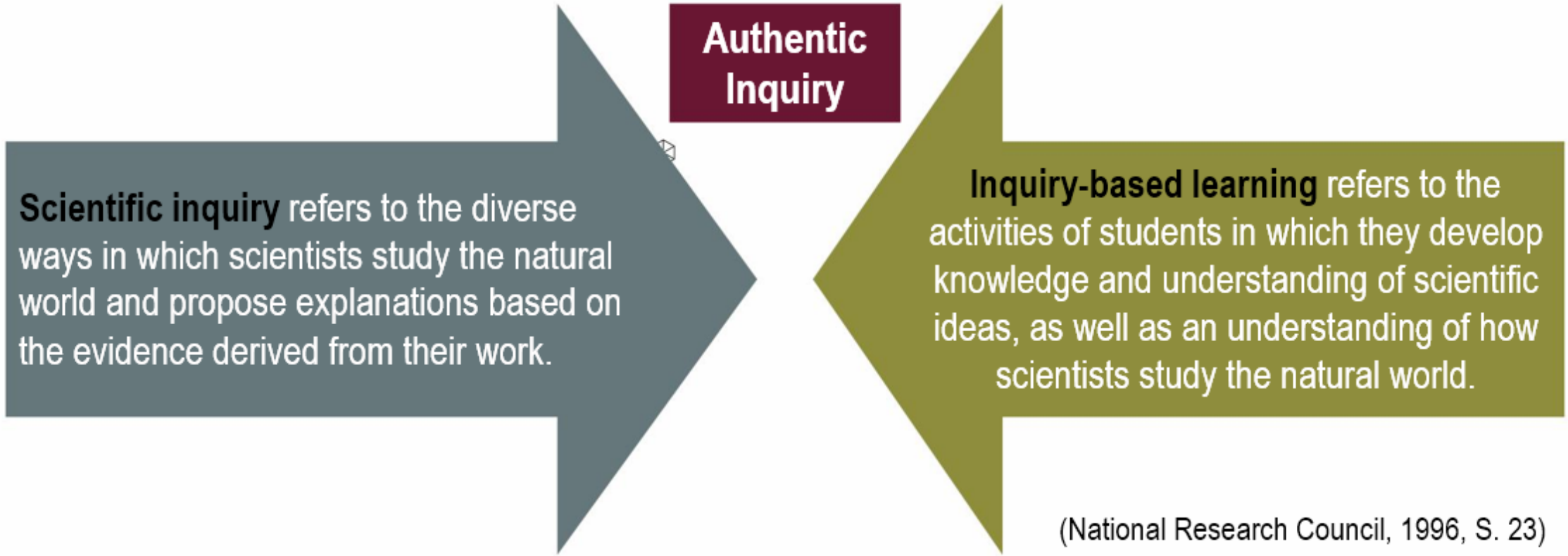

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Charactersistics – Inquiry-based learning

Essential characteristics (Hofer & Lembens, 2021)

- Existence of a question or problem as a starting point
- An investigation process tailored to the question / problem definition
- Utilisation of the data and results obtained in the research process to answer the initially answer or process the initially defined question / problem

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Activities – Inquiry-based learning

- Asking questions and defining problems
- Develop and use models
- Planning and carrying out investigations
- Analysing and interpreting data
- Apply mathematics and computational thinkin
- Construct explanations and develop solutions
- Argue on the basis of evidence
- Obtain, evaluate, and communicate information

(NGSS Lead States, 2013)

3 overarching goals of inquiry-based learning

LEARNING

SCIENTIFIC CONTENT

LEARNING

TO DO INQUIRY

LEARNING

ABOUT INQUIRY

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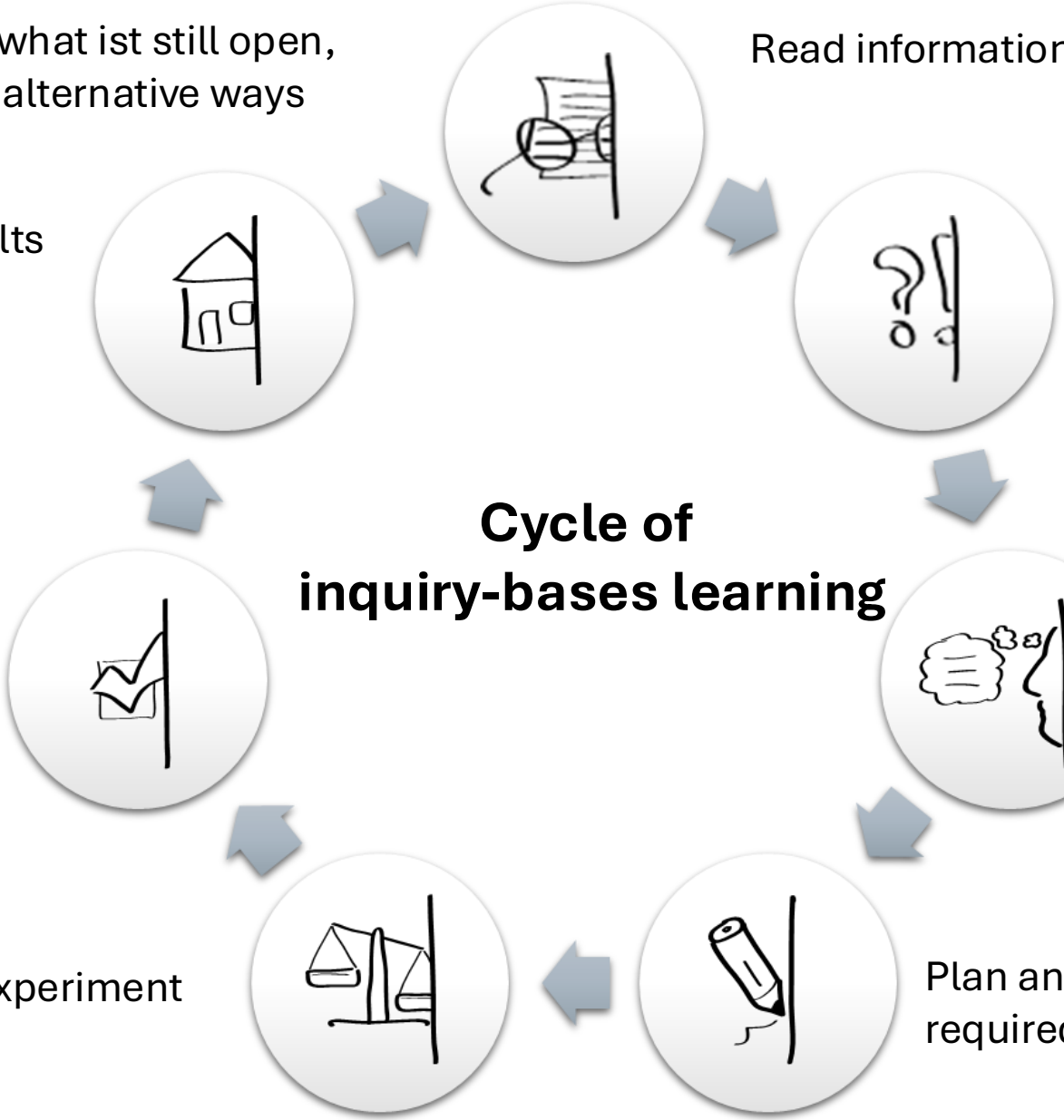
Cycle of inquiry-bases learning



Read information, talk about problems, discuss

Ask question

Form hypotheses, fall back on (subjective) theories

Plan an experiment, note required materials

Conduct the experiment

Analyse data, interpret, establish connections

Present results

Recognise, what ist still open, think about alternative ways

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4 levels of inquiry-based learning

	QUESTION	Methods, Proceedings	Evaluation - Interpretation
Level 0: *Confirmation*	Teacher	Teacher	Teacher
Level 1: *Structured*	Teacher	Teacher	**Students**
Level 2: *Guided*	Teacher	**Students**	**Students**
Level 3: *Open*	**Students**	**Students**	**Students**

(Blanchard et al., 2010, S. 581)

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Level 0: Confirming inquiry-based learning

Level 0 is suitable for:

- to learn how to handle equipment and carry out certain examination methods (e.g. filtration, titration, measurement, microscopy, etc.)
- to learn technical terms, designations and specific expressions
- to learn how to document and record examination
- to explicitly discuss aspects of Nature of Science / Nature of Scientific Inquiry
- to practise reading and following work instructions and safety regulations

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Level 1: Structured inquiry-based learning

Level 1 is suitable for (in addition to the aspects of Level 0):

- to learn how to observe and record observations
- to learn how to carry out investigations
- to apply prior knowledge to draw conclusions
- to practise interpreting results in groups
- to practise discussing and defending conclusions.

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Level 2: Guided inquiry-based learning

Level 2 is suitable, among other things (in addition to the aspects of Level 0 and Level 1):

- to formulate hypotheses
- to plan investigations and consider influencing factors (quantities, devices)
- to control variables
- to justify the choice of method

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Level 3: Open inquiry-based learning

Level 3 is suitable, among other things (in addition to the aspects of Level 0, Level 1 and Level 2)

- to formulate scientific questions
- to take responsibility for a complete investigation process

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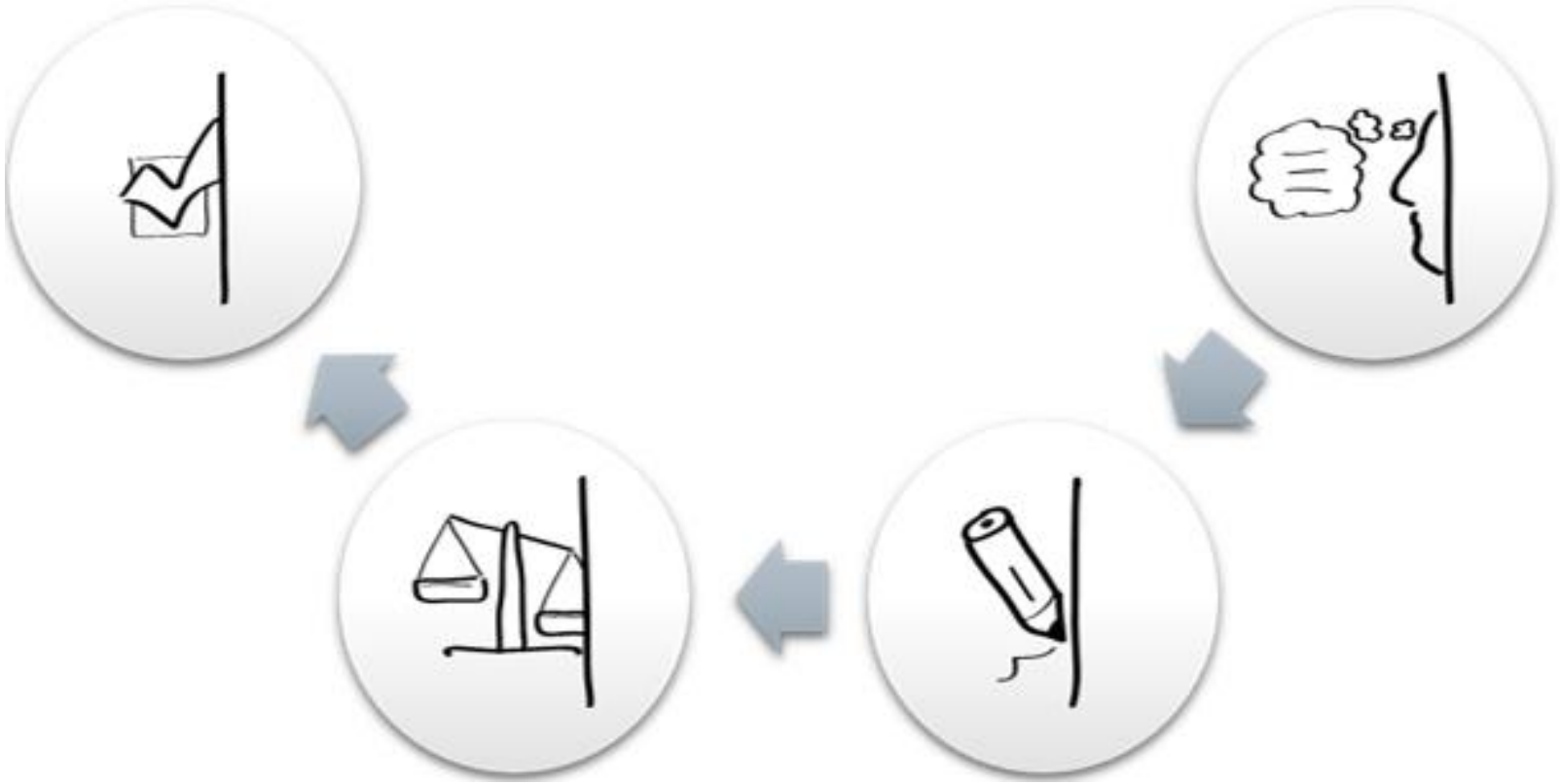
Practising the formulation of hypotheses



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Practising the formulation of hypotheses

First you have to observe carefully! Look, smell, feel!

What happens to a drop of alcohol on a piece of paper?

Students should formulate as many hypotheses as possible!

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Practising the formulation of hypotheses

H1: The alcohol seeps into the paper.
H2: Alcohol goes up in the air.
H3: Alcohol spreads evenly on the paper surface.
H4: Alcohol decomposes with the bacteria on the surface.
H5: The table removes the alcohol from the paper.

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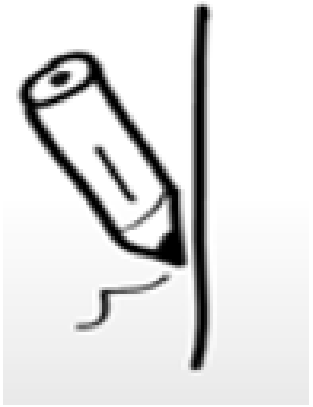
Practising planning an experiment

Students should consider which materials are necessary to test the hypothesis.



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Verification

After conducting the experiment, the hypothesis must be tested.

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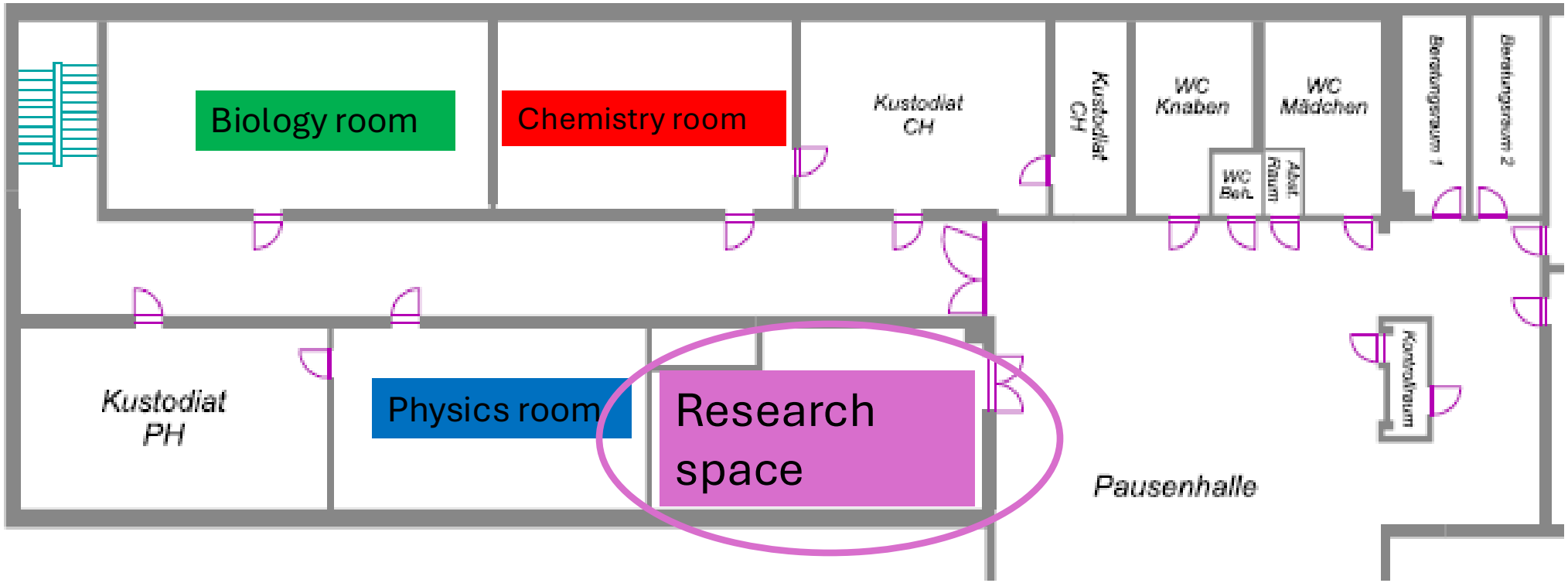
Science teaching - 2nd floor



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