inspiring SCIENCE education

Guidelines for Designing ISE Lessons/Educational Scenarios

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Content

Annex

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GUIDELINES FOR DESIGNING AN ISE SCENARIO

Introductory words

These guidelines should serve as orientation if you like to integrate an existing lesson/scenario in ISE or if you like to plan a new ISE lesson/scenario. After you designed a lesson/scenario you can upload it to the ISE authoring tool, so that it can be processed online (e.g. shared with other partners/teachers, cloned, and delivered). Of course you can also plan your lesson directly within the ISE authoring tool. If you want your lesson/scenario to be a Demonstrator you also have to add problem solving questions (guidelines in the attachment, for questions contact ruediger.tiemann@chemie.hu-berlin.de). The decision if a lesson/scenario will be used as Demonstrator will be made under the leadership of WP3. You can suggest your scenario as Demonstrator here: Maximiliane.schumm@uni-bayreuth.de.

A Demonstrator is an **example lesson** or an example scenario demonstrating the pedagogical approach of inquiry-based teaching and learning following the ISE principles.

1.) Characteristics of ISE Lessons/Educational Scenarios

Please read the following characteristics of ISE Demonstrators. Also your scenario has to meet all of these 7 characteristics:

1. Clear (for teachers and students on what they have to do) and simple (to use, adopt, change, flexible)
2. Inspiring and Motivating
3. Relevant to students (real world problems) and teachers (syllabus connection)
4. Working (complete, all links and material available)
5. Inquiry based
6. That they include online tools and resources
7. That they follow at least one Big Idea of Science

2.) Big Ideas of Science

Please choose at least one Big Idea of Science your scenario supports (Harlen, 2010),

1. ll material in the Universe is made of very small particles. Light in all different wavelengths permeates the Universe.	2. Objects can affect other objects at a distance.
3. hanging the movement of an object requires a net force to be acting on it.	4. The total amount of energy in the Universe is always the same but energy can be transformed when things change or are made to happen.
5. Changing the movement of an object requires a net force to be acting on it.	6. The solar system is a very small part of one of millions of galaxies in the Universe.
7. Organisms are organised on a cellular basis.	8. Organisms require a supply of energy and materials for which they are often dependent on or in competition with other organisms.
9. Genetic information is passed down from one generation of organisms to another.	10. The diversity of organisms, living and extinct, is the result of evolution.

3.) The five learning activities

For the explanation of the content **please use** the ISE-activity-terms **and follow** the description below.

Orienting & Asking Questions
Hypothesis Generation & Design
Planning & Investigation
Analysis & Interpretation
Conclusion &Evaluation

Orienting & Asking questions

Orienting: Provide contact with the content and/or provoke curiosity:

The process of inquiry can be focused on **answering a question**, but also on other goals, such as investigating a controversial dilemma or solving a problem. A teacher can introduce this with a

- classroom discussion and support it, for example, with
- narratives,
- videos, or
- simulations.

The students can take notes, ask questions, and discuss the contents.

Define goals and/or questions from current knowledge

Knowing when the learning activity has been successfully completed necessitates **clarifying the goals** that should be achieved, or the criteria that should be met. The goal of a scenario can be **formulated as a question or problem** that appears during the first contact with the content.

The questions or goals of the scenario can be written down to see afterwards if the goals were met or the question can be answered.

Hypothesis generation & Design

Generation of Hypotheses or preliminary explanations

Together with students' prior knowledge and the notes they have taken, the structure of the question/problem/goal forms the basis for **formulating hypotheses**, which can be considered as supposed relations between measurable dependent and independent variables.

- Learners build up hypotheses based on question or problem
- Learners can be supported by classmates, software or the teacher
- If questions are open-ended hypotheses can´t be tested but their plausibility can be scientifically justified

The hypotheses can be written down as well to test them afterwards.

Design/Model

Another approach to investigating hypotheses is to **design a model**. The appropriateness of models can be evaluated by relating it to the notes that students made during the learning process.

Planning & Investigation

Plan investigation

Clearly formulated hypotheses facilitate planning the work process. **Planning** includes determining the order of activities and intermediate goals, which tools and/or data to use, a clear time line, and how these activities can be divided among the participants.

There could be planned:

- Experiments
- Literature research
- Surveys
- Etc.

Perform investigation

Investigations can be performed by conducting **experiments** or designing artifacts, using physical or virtual tools.

In this activity students also can **gather data** from:

- Experiments (virtual or physical hands-on experiment)
- Literature research (online or analog)
- Surveys (online or paper and pencil)
- Etc.

Analysis & Interpretation

Analysis and Interpretation: Gather result from data

After data has been collected, it has to be processed for reading the information out of it. Depending on the gathered data or information, this step can be very complex. Therefore the teacher and/or an **analysis-tool** can help.

Teachers can support the students' process of **data investigation** by organizing the data collected and interpreting them by identifying key issues.

When solving problems, solutions found by experts can also be examined, and compared with the students' own solutions for the same problem.

The opinions or results of experts can be found by students via online or offline inquiry provided by the teacher via links/documents/other materials.

Conclusion & Evaluation

Conclude and communicate result/explanation:

Arriving at conclusions in the inquiry process can mean achieving

- consensus about a solution to a problem,
- producing a common artifact, or

- synthesizing views to arrive at a mutual decision.

The evaluation process can be facilitated by **presenting conclusions to a broader audience**, as this allows for replication and/or endorsement of the presented results.

Learners can use common **presentation tools** like power point but also online tools for sharing results with e.g. students of other classes or other schools

The teacher has to prove the results of the learners. He/she has to intervene when substantial mistakes are not found or corrected by the peers.

Evaluation/reflection:

As it is important not only to arrive at a **conclusion,** e. g., solving a problem, but also to have actually learned something, **reflection** is necessary to allow for recognition of similar problems (questions/cases) in the future, **transfer of knowledge** to such situations, and the ability to **apply** the learned strategy.

Besides **evaluating** one's own outcomes, it can also be interesting to evaluate others' outcomes and determine the extent to which they meet the **goals/questions/hypotheses** set. When determining whether learning goals are achieved, it can be valuable for future inquiry activities to identify what factors have been **facilitators or barriers** in attaining the goals.

- If an activity does not work out in the way it was expected, then learners have to try to find the reason why it does not work out.
- The **teacher** can support the process by **providing questions or methods** for reflection or evaluation

Consider other explanations

For investigation of controversial cases, different perspectives on approaching the case can be analyzed, and the **value of different information sources can be evaluated**. These processes can generate **new questions** for further inquiry.

The different information sources can be found by the students themselves or provided by the teacher via links/documents/other materials.

Table 1 Explanation of the ISE inquiry activities

Note: The framework we provide here with five main activities and subactivities is meant as a suggestion. Not every subactivity needs to be done (you can delete subactivities of not needed). But you can also add more subactivities if you need them.

You can insert materials like eTools, resources, pictures, videos etc. from the ISE repository (http://portal.opendiscoveryspace.eu/ise), ISE Tools Repository (http://portal.opendiscoveryspace.eu/repository-tool) and also your own digital resources wherever they support your teaching goals.

4.) ISE eLearning tools

Use an ISE tool in your scenario (here you can find the ISE eLearning tools: http://portal.opendiscoveryspace.eu/repository-tool)

If the tools you use in your current scenario are not ISE tools yet you can fill in the google form (https://docs.google.com/forms/d/1xhb5zIQTTni2zHWasDWMuse94djXps72hz0tIOT06wk/viewform) to suggest a tool as ISE eLearning tool.

5.) Resources

Enrich your scenario with resources (pictures, texts, films). You can use your own resources and use them directly from your Computer, add them as links or via ODS repository.

6.) Problem solving questions

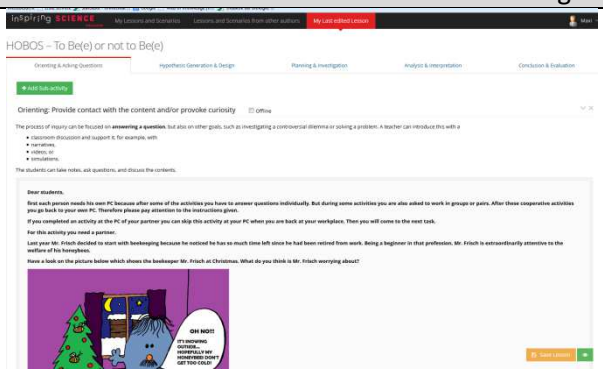
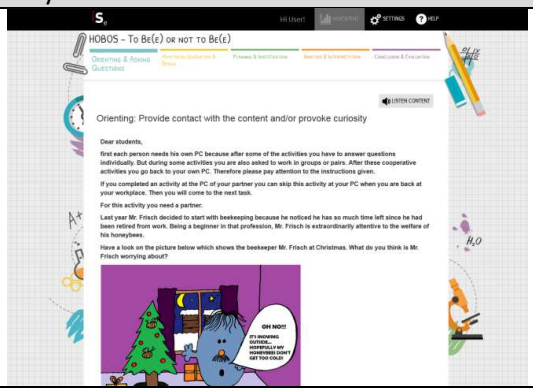
If you want your scenario to be a Demonstrator **add problem solving questions.** For questions and review contact: ruediger.tiemann@chemie.hu-berlin.de

The guidelines for setting up assessment questions you can find attached (Annex A and B).

7.) ISE Authoring tool and ISE delivery environment

Upload your lesson/scenario to the authoring tool so that is it usable via the delivery environment

Short explanation of the ISE authoring tool and the ISE delivery environment:

ISE Authoring tool	ISE Delivery environment
1. The authoring tool supports you to structure and plan your lesson/scenario.	2. The delivery environment brings the content you added in the authoring tool directly to the student.
3. Therefore it is important to directly address the students in your scenario e.g. “Please click on the link … and try to answer the following question… “	4. In the delivery environment the students see e.g. “Please click on the given link and try to answer the following question… “
5. Please add in the authoring tool also guidelines for teachers in **an extra box** (select “guideline”) e.g. “Students now working with the website … . They should answer the following question … . The answers to the question can be … . And here you can find some background information…”	6. Only teachers see the additional information you added for them.
Screenshots of authoring and delivery environment	
	

You can also use and clone scenarios created by other users under “lessons and scenarios from other authors”. Please do not “deliver” test-scenarios or similar, keep them as draft versions.

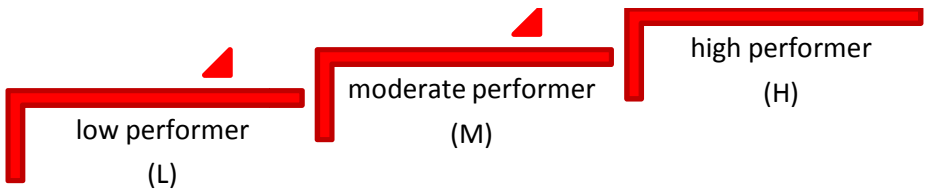
Guidelines for how to use the ISE authoring and delivery tool you can find here:

- Video of the authoring tool webinar: *https://www.youtube.com/watch?v=zwlXqYIJuyc*
- Current teacher guide for using ISE portal and Demonstrator chasing comets (NUCLIO): Youtube → **Chasing Comets - A teachers' guide,** https://www.youtube.com/watch?v=UOjf39BKVE0
- Furthermore you can find guidelines for the authoring tool here “Guidelines for using the ISE authoring and delivery tool”: http://portal.opendiscoveryspace.eu/sites/default/files/u39/ise_-_guidelines_for_using_ise_authoring_and_delivery_tool-17_02_2015_0.pdf

Before you can upload your scenario you have to fill in information about **metadata** of your scenario. In order to know which points you have to take into consideration you can find a list of the metadata you have to fill in when uploading a scenario in annex C.

Brief summary of how to design the tasks:

With the help of this Guideline you will design tasks to detect the level of performance of your students. You will design one task with three different options to answer, one for each level. Depending on the performance of your students, they will be on one of these three levels.



Suggestions to formulate adequate questions for each level:

Students proficient at **high level** can

- develop complete, coherent mental models of different situations
- can find an answer through target exploration and a methodical execution of multi-step plans

To estimate the difficulty of the tasks for this level, an average of about 10% of your students (15-year-old) should be able to answer on this level.

Students proficient at **moderate level** can

- control moderately complex devices, but not always efficiently
- handle multiple conditions or inter-related features by controlling the variables

To estimate the difficulty of the tasks for this level, an average of about 45% of your students (15-year-old) should be able to answer on this level.

Students proficient at **low level** can

- only answer if a single, specific constrain has to be taken into account
- only partially describe the behaviour of a simple, everyday topic.

To estimate the difficulty of the tasks for this level, an average of about 45% of your students (15-year-old) should be able to answer on this level.

Suggestions to formulate adequate questions for each step:

(1) Exploring and understanding	(2) Representing and formulating	(3) Planning and executing	(4) Monitoring and reflecting
Questions - …dealing with the representation of the problem - …about relevant information to understand the problem - …dealing with different levels of understanding of content knowledge	Question - …concerning the exploration of correlations and dependencies -…concerning a precise description of the focused problem	Question -…concerning the correct strategies of experimentation -…concerning strategies of variable control -…concerning strategies of data analysis	Questions -…about application or transfer of the tasks -…about possible sources of experimental errors -…about enhancement of experimental setting

Level of proficiency in problem solving	Exploring and understanding	Representing and formulating	Planning and executing	Monitoring and reflecting
Question 1	**Why do we need to think about renewable energies?**	**Which domains have to be taken into account for the change in energy supply to be successful?**	**Which consequences can the increase of the price for electricity have?**	**What advantages has the use of a simulation against the look at a whole real world scenario?**
High level	Because we are responsible for our future	Because of interdependencies social, economical and ecological aspects have to be considered.	Government has to think about how to disencumber citizens and companies which can't afford higher prices.	Because of learning by trial and error I get a deeper understanding of the content.
Moderate level	Because as responsible citizens we have to be informed and able to discuss current issues	It's important that no jobs get lost or alternative jobs or retraining are offered to employees. Also investors have to be recruited.	Energy supply is an important economic factor. Companies may threaten with migration to a more cost-effective location.	Because it's not possible to manipulate the real world conditions in the same way as in a simulation.
Low level	Because it's very present in media	People have to be well prepared for the change in energy supply. So it's very important to promote the change and tell people why it is needed.	People become dissatisfied because they have to pay more money for electricity	Because it's funny to play with the simulation I'm more motivated to learn.
Question 2	**CO_2 is a problem, because…**	**What is the best way to start change in energy supply?**	**What happens if a power plant is switched off without substitution?**	**The discussion about renewable energies and also the simulation mostly ignore important factors. An important but ignored factor is:**
High level	CO_2 is accumulating in the atmosphere and reflecting thermal radiation from the earth so it can't leave the atmosphere. This contributes to the	Change in energy supply would be easier and faster when less energy has to be produced.	Energy supply is an important economic factor. Lack of reliable energy supply can lead to degeneration of a highly developed country.	Use of fossil fuels for transportation and heat production

	anthropogenic greenhouse effect.			
Moderate level	CO_2 is jointly responsible for human made climate change	It's important to reduce energy consumption	Energy supply is not guaranteed	Importance of cogeneration of heat and electricity
Low level	CO_2 is harmful to the environment	One first step is e.g. to switch of light when leaving a room.	Cities getting dark	Use of coal for barbeque
Question 3	**What happened if there was no natural greenhouse effect?**		**For running an impeller with renewable energies you can use:**	
High level	Because all thermal radiation leaves earth atmosphere directly temperature on earth wouldn't exceed -18°C		Each thermal power plant works in almost the same way: Water is heated by fuel and moves the impeller. As fossil fuels you can burn every renewable material to heat the water.	
Moderate level	Under these conditions no life on earth would be possible		You can use every renewable resource to move it.	
Low level	It would be very cold on earth		As you can see in the landscape impellers are moved by wind.	

Metadata you have to fill in before uploading a lesson/educational scenario to the ISE authoring tool

- Title (Title is the name given to this lesson/educational scenario)
- Short Description (Description is a textual description of the content of lesson/educational scenario)
- Keywords* (Keyword is a text or phrase reflecting the topic of this lesson/educational scenario)
- Language* (Language is the primary human language used within this lesson/educational scenario to communicate to the student)
- License level (The license assigned to this lesson/educational scenario)
- Context of use* (The principal environment within which the learning and use of this lesson/educational scenario is intended to take place)
- Age*(the age group that this lesson/educational scenario intends to afress)
- Prerequisites (any prerequisites required for executing this lesson/educational scenario)
- Level of difficulty* (how hard it is to work with or through this lesson/educational scenario for the typical target audience)
- Duration* (the total duration needed to execute this lesson/educational scenario)
- Special needs* (whether the lesson/educational scenario addresses people with disabilities)
- Cognitive Objectives* (please provide educational objectives for this lesson/educational scenario according to the Bloom's Taxonomy)
- Affective Objectives* (please provide educational objectives for this lesson/educational scenario according to the Bloom's Taxonomy)
- Psychomotor objectives* (please provide educational objectives for this lesson/educational scenario according to the Bloom's Taxonomy)
- Big Ideas of science* (Please select one or more Big Ideas of Science that is/are followed by the lesson/educational scenario
- Subject domain* (describe this lesson/educational based on the science taxonomy)
- Coverage (describe whether this lesson/educational scenario can be used for covering different regional areas)
- General structure* (Structure is the underlying organizational structure of this lesson/educational scenario)
- Interactivity level* (The degree of interactivity characterizing this lesson/educational scenario)
- Intended End User Role* (principal user (s) for which this lesson/educational scenario was designed)
- Educational aspects (please provide any other educational aspects related with this lesson/educational scenario)
- Cost* (whether use of the this lesson/educational scenario requires payment)
- Copyright and other restrictions* (whether copyright or other restrictions apply to the use of this lesson/educational scenario)

*answers to select

CHECKLIST FOR DESIGNING A SCENARIO

7 steps to an ISE scenario

	Check?
I have an **idea** for a scenario	
1) I'm aware of the **characteristics** a **ISE scenario** should have and I think my scenario can be in line with them	☐
2) I have chosen at least one **Big Idea of Science** my scenario will follow	☐
3) I have planned the scenario by using the **ISE terms** for **learning activities** and the activities follow the guidelines (Table 1)	☐
4) My scenario makes use of an **ISE eLearning-tool**	☐
5) **I enriched my scenario** with resources (pictures, texts, films)	☐
6) I **added problem solving questions** because I want my scenario to be a Demonstrator	☐
7) I **uploaded** my scenario completely to the **authoring tool**	☐