

Open Inquiry

At the fourth and highest level of inquiry, **open inquiry**, students have the purest opportunities to act like scientists, deriving questions, designing and carrying out investigations, and communicating their results. This level requires the most scientific reasoning and greatest cognitive demand from students. They will have to select the field of research, identify relevant existing theories and placing it within its contexts, make predictions, collect and analyse the data using the right methods and tools, discuss and present the results. It is the hardest form of inquiry and the one that is not often used in school settings.

The microclimate scenario

The scenario used to show case the weSPOT IBL model is a scenario within a secondary education context, about microclimates (Mikroyannidis, Okada et al. 2013). Microclimates are areas where the normal temperature and conditions are slightly different from the surrounding areas. The aim of this scenario is to find the best place to have a bench at the school. The initial hypothesis is that the best place is the garden site nearest the school entrance because it is sheltered from the wind but south facing, so it is warm and not windy there. Other places to be considered are the car park, the canteen, the games area and the reception.

The scientific questions proposed by the teacher are:

- *Where is the windiest part of the school grounds?*
- *Where is the sunniest part of the school? This is likely to be the warmest.*
- *Where will we find the warmest part of the school grounds?* (Mikroyannidis, Okada et al. 2013).

Therefore, the inquiry is based on four measurements: speed of wind, sunny periods, temperature and humidity.

Phase 1 - Question or hypothesis. At this phase the students need to define the research area and produce their inquiry hypothesis. The teacher might offer some guidance but the student is the one who defines the field of research (e.g. Microclimate) provide all the supplementary materials and explanations, such as what microclimate is, definitions, additional background resources etc. He/she is the one who will decide if there is a need to cover all the sub phases of the IBL model. Some example specific questions that the students can work on can be the following:

- *What are the energy sources in the classroom?*
- *What quantity of energy do they consume?*
- *Is there a relation between external climate and energy consumption?*

- *How long is the air-conditioner working during the day and at what temperature?*
- *What measures could be taken to minimize the energy consumption (e.g. do not open windows, do not leave the door open during breaks, do not switch the light on during the day, etc.) (Mikroyannidis, Okada et al. 2013).*

Phase 2 - Operationalisation. At the stage of operationalisation the students need to investigate different research methods and decide what information they need, how they can collect it and what needs to be measured, how it will be measured, decide on specific indicators and make prediction. The students will have to take control of their learning and make the decisions. Some of the activities can be the following:

- *To measure the temperature inside and outside three times a day (morning, midday and evening).*
- *To compare the temperature in the classroom and outside the building.*
- *To check during the measurement if the window or the door are open.*
- *To watch external climate conditions (sunny, windy, rainy etc.)*
- *To check when the air-conditioner is on and off.*
- *To calculate the energy consumption of the air-conditioner.*
- *To search the web for the most efficient way of use of the air-conditioner they have in the classroom.*
- *To check how often the lights are on and off.*
- *To calculate the energy consumption of the lights.*
- *To check how long the sunlight is enough during the day.*
- *To make informal questionnaires with their parents and relatives about how they save energy (Mikroyannidis, Okada et al. 2013).*

Some of the subtasks maybe excluded from the processes because they do not fit the scope of the specific topic, for example in the microclimate example the ethical aspects might not be important and therefore do not take them into consideration. However, only the student will decide and justify his decision. Reflection will be present through the process but the student should be able to reflect upon his/her actions and evaluate them.

Phase 3 – Data collection. At this phase students collect the data it has chosen to measure by using the appropriate method and the appropriate tools, for example by taking pictures of the appropriate places that the bench can be placed or record measurements of temperature and/or wind speed, humidity and store their data in a secure and safe way. However, they need to make all the decisions on the tools that they have to use, for example in this scenario, smartphones, thermometers, anemometer etc., where to store the data (e.g. database, computer etc.). The teacher can offer support and guidance if needed but the students are responsible for the decision. Reflection at this phase is also at students hands. They have to evaluate their decisions and actions and be able to justify them. Reflection can take place either individually or in groups and the teacher can offer support but avoid guiding the process.

Phase 4 – Data analysis. At the data analysis phase the students analyse the collected data by using the appropriate method and tools. They have to choose the type of analysis that they will perform, qualitative or quantitative, the tools to be use, for example excel, SPSS etc. The students

using the tools they prepare diagrams and graphics based on the temperature, wind speed measurements, and humidity and identify relations between different factors influencing their decision about the best place to place the bench (temperature, wind speed, sunny intervals etc.). Reflection at this step is very similar to the reflection described in the phase above. At this phase, the teacher can offer guidance if needed but the students make all the decisions.

Phase 5 – Interpretation/Discussion. At this phase the students have again full control of the process. They draw conclusions based on their data analysis, relate to the hypothesis and discuss different decisions and results. They decide on the relevance of their results, their significance, and they place them within the appropriate research field, microclimate, by comparing them to other existing works. So they look for other relevant works on the topic of microclimate and ways of recording the measurements such as temperatures, wind speed, humidity etc. The students then make interpretations of the obtained data and draw conclusions about the best place to place the bench. On the basis of final decisions the students prepare a list with suggestions such as:

- *The best place to put the bench is the garden.*
- *The best place to put the bench is the south garden.*
- *The best place to put the bench is by the gym.*

Phase 6 – Communication. The students prepare their presentations, conclusions and recommendations, and give arguments (data, tables, diagrams, pictures), decide on how to disseminate the results. However, the teacher here only provides guidance if needed. The students decide about their audience, for example, it is going to be their fellow students' teachers, parents etc., and the tools they need to use for the presentation (PowerPoint, overheads etc.). Different audiences may require different types of communication. For example, for the given microclimate scenario the students might decide that the audience will be the fellow students and the appropriate tools to use is a report and a presentation. Then they will need to write the report and prepare the presentation alone. They decide on the tools they need to use and how can incorporate the feedback they might get from the fellow students or peers. Throughout this phase, reflection is at the centre scrutinising every single step or decision either alone or with their peers. Each team or student then makes its presentation in front of the fellow students and receive feedback.