CHAPTER 1

DEEPENING YOUR KNOWLEDGE AND USE OF THE INQUIRY-BASED APPROACH

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To understand and reuse the IBL (Inquiry-Based Learning) approach, the Let's STEAM materials have been designed to approach the training resources without the already-made solution. Our goal is to help you develop your own solutions to problems you would want to solve with your students in the classroom.

Inquiry-based learning (IBL) is an educational flexible strategy with phases that are often organized in a cycle and divided into subphases with logical connections depending on the context under investigation (Pedaste et al., 2015 - Margus Pedaste et al. Phases of inquiry-based learning: Definitions and the inquiry cycle, Educational Research Review, Volume 14, 2015, Pages 47-61, ISSN 1747-938X, https://doi.org/10.1016/j.edurev.2015.02.003). This framework entails five general phases (Orientation, Conceptualization, Investigation, Conclusion and Discussion) and seven sub-phases (Questioning, Hypothesis Generation, Exploration, Experimentation, Data Interpretation, Reflection, and Communication).

FOCUS ON AN INQUIRY-BASED LEARNING APPROACH (OR IBL)

IBL can be used in order to conceptualize a structured way to implement inquiry activities and develop multidisciplinary educational projects in the classrooms. IBL is not a linear procedure and learners should be involved with various forms of inquiry, going through different combinations of the phases, not all of them necessarily. For example, if the data analysis is not satisfactory enough, students can return to the conceptualization phase and reconsider their question and/or their experimental design. When students come to a conclusion, new questions can be generated, and the process starts again in a progressive fashion. A description of the processes of IBL by Pedaste et al. comprises the five phases described below:

- **Orientation**: Orientation is the phase where the identification of the problem occurs. The topic to be investigated is presented and interest in a problematic situation that can be answered with inquiry is stimulated. The topic under investigation must be relevant to students' daily life, interests and prior knowledge. The teacher's role in this phase is to encourage students to express ideas, prior knowledge and questions about the topic while promoting interaction and communication between them. For example, students can create concept maps of what they know, do not know or want to know about the topic under investigation. These kinds of activities can also be useful for the next phases of inquiry.

- **Conceptualization**: Conceptualization refers to the understanding of the concept, which relates to the problematic situation presented in the previous phase. It is divided into two subphases (questioning and hypothesis generation) that lead the learner to the investigation phase. The teacher's role in this phase is to help students understand how they can formulate questions and/or hypotheses that can lead to an investigation. If students are not familiar with the questioning and hypothesis generation subphases, the teacher can choose a structured type of inquiry at first and then progress in more open types of inquiry in order to provide the appropriate guidance.

    - ***Questioning subphase***: Questions are formulated in order to design an investigation that produces answers. As this skill is developed through inquiry, students can gradually understand which question can lead to investigation and which one is more generative and might lead to different or richer processes.

    - ***Hypothesis Generation subphase***: A hypothesis is generated by providing explanations of how the identified variables relate (Pedaste et al., 2015). It explains how and why phenomenon function based on former experiences and prior knowledge.

- **Investigation**: Investigation is the phase where students collect evidence in order to answer their questions and/or test their hypothesis and includes the subphases of exploration, experimentation, and data interpretation. The teacher provides materials that the students might need and keeps them on track so that the process they choose to follow is a process that answers the investigative question. Students should determine what constitutes evidence and collect it. If they are not familiar with this process, a structured type of inquiry can be chosen. The teacher can provide or encourage students to create means (e.g. tables, charts, etc.) that can help them organize, classify and analyze the data.

- ***Exploration subphase***: Exploration is an open process that generates mostly data concerning the identification of a relationship between the variables. It is chosen typically when the question that was formed in the previous phase was generative because students do not have a specific idea of what to explore or how the identified variables relate to each other (Pedaste et al., 2015).

- ***Experimentation subphase***: Experimentation includes the design (e.g. choosing the materials and means to measure) and performing of experiments taking into consideration the variables that need to change, remain constant and be measured. The products of this subphase are data or evidence that can be used later on for analysis and interpretation.

- ***Data Interpretation subphase*:** Depending on the concept under investigation and the inquiry procedures that were chosen, finding relations between the variables is sometimes the key to getting the desired outcome (answering the investigative question). Organizing and classifying the data (with graphs, charts, tables, pictures, etc.) can benefit this process.

- **Conclusion**: In this phase, students draw conclusions based on the investigative question and the interpretation of the data. The teacher's role during this phase, a comparison between the interpreted data and the predictions and initial ideas (that the students expressed during the orientation phase) can be stimulated. This process can also lead to new hypotheses and questions about the topic under investigation.

- **Discussion**: During the discussion phase students articulate their findings through communicating them to others and/or reflecting upon all or some of the stages of inquiry during the processor by the end of it (Pedaste et al., 2015). The teacher's role is to encourage collaboration so that students can present their findings and ideas, provide arguments and give feedback to others. If they are not familiar with these practices, the teacher can provide guidelines that will help them to communicate during all the phases of inquiry.

    - ***Communication subphase***: Communication includes a discussion with others and representation of results in a manner that is understandable to all (National Science Foundation, 2000). It can be applied to a single phase or the whole cycle of inquiry and is usually an external process (Pedaste et al., 2015).

    - ***Reflection subphase***: In this subphase, students reflect on their work, their results and the concept under investigation. Reflection can even give rise to new thoughts regarding the inquiry cycle or a single phase.

TYPES OF INQUIRY

The types of inquiry vary so that students are actively involved in the process to the extent that they are competent and able to do so. The type of inquiry a teacher may choose to follow is highly dependent on the objectives of the lesson, the age of the students, their previous involvement with inquiry and the scientific skills they have already acquired. As shown below, the more responsibility the student has, the less direction is provided and the more open the inquiry becomes.

The variations of inquiry types concern the increasing or decreasing involvement of the teacher and student in the process. Structured inquiry is directed from the teacher so that students reach a specific result, whereas in mixed inquiry students are more involved during an investigation with the teacher guidance still being the most dominant. These forms of inquiry usually are chosen when students are first introduced to inquiry practices and when there is a focus on the development of a specific skill or concept. Open inquiry provides more opportunities for developing scientific skills, given that during the open inquiry the students work directly with the materials and practices in a way that resembles authentic scientific approaches.

For example, if students lack previous experiences with designing investigations and collecting data, a more structured or guided form of inquiry should be chosen. When students acquire the skills needed, they can progress to more open inquiry activities. Students should at some point participate in all the forms of inquiry, while gradually moving from one form of inquiry to another with the simultaneous progression of complexity and self-direction.

GUIDE... WITHOUT LEADING - IBL ADAPTED TO THE LET'S STEAM MATERIALS

To understand and reuse the IBL approach, the Let's STEAM materials have been designed to approach the training resources without the already-made solution. Our goal is to help you develop your own solutions to problems you would want to solve with your students in the classroom. The appropriation of the work will be more important and will facilitate the future transfer to your classes. For inspiring you, several problems can be offered in order to address the different fields of STEAM but also to target the potential interests of your classroom. You will hence find in this coursebook, in addition to our template, a pool of problems.

And keep in mind that by using the template and associated resources you will find in the second part of this coursebook, you are also a great contributor to the Let's STEAM materials! We invite you to share your productions with the Let's STEAM community and beyond!