

Inquiry-based learning as an active teaching method

Experimentation, establishing interrelationships, interpreting phenomena: inquiry-based learning stands for “acquiring knowledge actively.” This method is particularly well suited to the STEM subjects and their scientific questions. Research, experimentation, analysis, presentation, and documentation are especially effective avenues for the students to acquire knowledge and learn research methods. They also acquire specialized knowledge and key competencies in the process. Under a teacher’s guidance, the students gradually learn to handle increasingly broad assignments on their own.

The Research Cycle

Investigate your own ideas and assumptions, try them out for yourself, and research issues – actively acquire knowledge. A crucial factor in the process is continuous advice, supervision, support and validation by the teacher.



Acquiring knowledge together

Hands on and minds on: With inquiry-based learning, students are supposed to pursue their own ideas and assumptions, try them out for themselves, and investigate questions. Insights gained through this kind of hands-on approach make a more lasting impression than knowledge acquired in a strictly theoretical manner. The teacher's role here is critical:

- Teachers provide the theoretical framework and explain terminology, theories, and models to the students.
- Teachers ensure an appropriate working atmosphere.
- Teachers always work with the researchers to link the results and insights back to the initial question and its meaning for the individual and society as a whole.

Inquiry-based learning already has a long tradition in Anglo-American pedagogy. But it is also an indispensable part of our science curricula. Because today's educational goals are strongly focused on the acquisition of skills. Inquiry-based learning has an important role to play here.

Basic conditions for inquiry-based learning

Several studies have shown that students can be overwhelmed by inquiry-based learning (see Clearinghouse 2017). But teachers can guarantee an effective educational experience by creating the right conditions for inquiry-based learning:

- **Select a relevant topic** for the students from which they can develop real-world-oriented research questions
- **Provide resources** that can be used to resolve open questions: lab equipment, books, computers, etc.
- **Ensure orderly work processes** from research, planning, implementation and experimentation to the analysis and finalization of the results
- **Support individual learning and research processes** of small and larger groups through high-quality feedback, explanations, and targeted tips

Teachers should pay attention to each individual student, encouraging and challenging each according to his or her own personal abilities without overtaxing them.

Learning objectives of inquiry-based learning

When the aforementioned conditions are in place, the objectives of inquiry-based learning are varied and sustained:

- **Increased motivation:** Students are the key players in their own learning process. This motivates them to explore content and objects.

- **Lasting sense of success:** The students develop solutions and results on their own, so they experience them as personal triumphs.
- **Deeper understanding:** Grasping the content and processes through hands-on work deepens the students' understanding.
- **Greater opportunities for action:** Students can transfer their actively acquired knowledge of content and methodology to other questions – in both scientific and social contexts.
- **Stronger team spirit and better communication skills in the subject matter:** This is achieved through collaboration in (small) groups.

Ultimately, the independent scientific research is intended to give students an adequate grasp of science and technology. The students also learn something about the “nature of science” (Höttecke 2014).

Theoretical learning background

Inquiry-based learning is closely linked to the concept of learning as a constructive process. The underlying assumption is that people develop cognitive structures based on their experiences and use these structures to develop an increasingly comprehensive understanding of the world. Infants, for example, learn about their surroundings using their hands and mouths while developing mental constructs that enable them to respond with increasing precision.

Dialog, reflection, and change of perspective are critical

The best way to promote constructive learning processes is through a “balanced and reserved measure of instruction” (Stangl 2018). In other words, the individual learning process is closely linked to a role model or instructor and various resources. Support is also found in a dialog with one's peers: Students gain different perspectives, reflect, and learn to adapt their expectations.

Another form of studying one's surroundings in science is the experiment or practical investigation. Every assumption that can be confirmed or rejected based on experience leads to new insights. This in turn leaves students better equipped to do well in real life.

Inquiry-based learning is especially effective

A hands-on study of objects and issues promotes learning – or even makes it possible in the first place. No one disputes that knowledge obtained through personal experience is more firmly anchored in the mind of learners. The link to a real-world context also strengthens the motivation and interest of the students. A balance between independent and guided study also achieves particularly good educational results, as many studies from the last 20 years demonstrate.

Reflection and the right feedback make the difference

Another factor that increases learning effectiveness is if the students have time when analyzing their experiments to talk about their own ideas. Studies that accompanied PISA 2015 determined that reflection is more important than further attempts at self-developed questions.

The Clearing House study (2017) ultimately concluded with the following summary for learning in conjunction with experimentation: “It’s all about the support!” The support provided by teachers should always include putting the students’ newly acquired insights into context through remarks such as, “Now you’ve learned that!” or “That’s how scientists work!” or “That’s a sensible strategy!” Such feedback is important, because it encourages the students and helps them understand their own learning process.