

Developing students' disciplinary thinking

What do students learn besides content? How do they make connections, synthesize what they've learned, apply ideas, and solve problems? Also, how do they carry over what they learned to apply in one context to a new situation, either in or out of the classroom?

In addition to learning content and concepts, students develop and apply skills in the analysis and problem-solving methods of your discipline. Classroom teaching strategies can help students develop expertise and apply higher order and independent thinking in considering and solving authentic problems in your discipline.

Differences between domain experts and novices

Within a discipline, experts differ from novices in ways that influence their abilities to think effectively about problems.

Some of the characteristics of domain experts' knowledge are:

- Experts notice features and patterns of information that novices may miss.
- Experts not only have a great deal of content knowledge, but their knowledge is organized in ways that reflect a deep understanding of their field.
- Expert knowledge is not simply a collection of facts and figures, but also incorporates contexts and circumstances in which how the knowledge is applied.
- Experts are able to retrieve relevant knowledge with little effort.
- Experts vary in their flexibility in applying and adapting their skills to new situations.

Some challenges to teaching students to develop domain expertise

The learning and application of knowledge to solving problems is different for experts and novices. Since experts already know and have organized content knowledge, they can relate new information to their existing knowledge. Novices, on the other hand, have less pre-existing knowledge, and less relevant pre-existing knowledge, so they may struggle with connecting new information, and may retain less of what they are trying to learn.

Expert blind spot

Instructions that seem clear to an expert, such as 'choose a meaningful problem' may be confusing to a novice. Students may be confused by directions that seem unclear to them, and they may spend time and effort attempting to interpret and follow the instructions in ways that may be unnecessary or inappropriate to the tasks.

The more expertise a person has, the more that accessing and applying their knowledge may be second nature. Experts may have developed blind spots regarding task complexity and thus they may underestimate the skills, knowledge, and processes needed to perform a task.

Cognitive load

A task that an expert sees as a single task may be perceived by novices as a number of separate tasks. For example, beginning drivers may think carefully about each of a multitude of individual steps involved in starting a car and monitoring driving conditions. In contrast, an experienced driver has integrated the several processes of driving and performs the steps more automatically.

The term 'cognitive load' refers to a limit people have in the amount of separate tasks we can perform and pay attention to simultaneously. Students' perception of cognitive effort can be impacted by the amount of new information and unfamiliar tasks they are being given, or by competing demands for their attention, such as viewing or interacting with multiple forms of media as they learn new information.

Some teaching strategies for domain knowledge and skill building

These are general descriptions of teaching strategies. The ideal instructional approaches may vary with the students' expertise level. Novices will likely need more guidance and structure, while more advanced students can work more independently.

Find out what students already know

Do students come to your course with the appropriate background information? Consider using ungraded assessments designed to check students' conceptual

knowledge. Doing these assessments at the beginning of the semester, or before a new topic, can give you information about students' background and level of preparedness.

Help facilitate knowledge organization

The term 'knowledge organization' refers to ways we make connections among ideas and information. Knowledge connections are based on what we've learned and experienced. Some examples of knowledge organizations are cause and effect relationships, parts of a whole, resemblances, and related meanings.

As one's associations grow over time and experience, their knowledge organizations allows for more complex structures. The knowledge structures that develop through experience then support one in using their knowledge to efficiently perform new, associated tasks. One way to help students incorporate new knowledge is to provide them with a system to guide them in organizing new information. Some example of structures include organizing principles, categories, or hierarchy.

Reduce students' cognitive load

When a learner perceives an assignment problem as a set of new or unfamiliar tasks, especially if these are performed at the same time, they may feel an overload on their attention, and may be unable to effectively perform the task. These strategies are intended to support students as they learn new information and apply new skills.

- Break down tasks into their component skills, to help identify the areas in which students will need targeted practice and feedback
- Allow students to develop and practice one skill at a time
- Give students practice and feedback at integrating component skills
- Consider the use of providing worked examples - problems with partial or complete solutions that students study before solving new, similar problems

Make thinking processes explicit

Bring thinking processes out into the open. You can make your own processes visible to students by talking through your approach to analyzing and solving a problem and sharing the information, related experiences, or general principles you draw upon.

Students can articulate their processes by describing and discussing how they solved or would anticipate solving a problem. Similarly, student-created concept maps can show you their current state of knowledge organization, and can help identify knowledge gaps or misinformation. As students become more aware of their thinking processes, they can learn to assess tasks, develop an approach, monitor their progress, and change their approach as needed.

Help students apply what they learn in different contexts

In addition to the ability to integrate and apply skills, mastery also includes knowing and choosing when to apply which skills in new situations, and out of the classroom.

Some teaching strategies to help students recognize situations to apply and adapt their skills include:

- Discuss, and have students identify and apply, skills and knowledge in different contexts
- Generalize to larger principles
- Use comparisons to identify ways problems share similar underlying principles, even if their surface features are different
- Provide prompts to help students connect relevant knowledge

References:

Ambrose, Susan A., et al. How learning works: Seven research-based principles for smart teaching. John Wiley & Sons, 2010.

Bransford, John D., Ann L. Brown, and Rodney R. Cocking. How people learn: Brain, mind, experience, and school. Expanded Edition, National Academy Press, 2000.



Academic Technology
DIVISION OF INFORMATION TECHNOLOGY
UNIVERSITY OF WISCONSIN-MADISON

Research-to-Classroom Studio

at.doit.wisc.edu/faculty-engagement/research-to-classroom-studio/