How People Learn: Brain, Mind, Experience, and School
Brief Summary & Implications for Teaching

Developing Expertise

Experts have acquired extensive knowledge that affects what they notice and how they organize, represent, and interpret information.

Key Findings:

Experts have a great deal of content knowledge that is highly organized; this organization reflects a deep understanding of the subject matter, and allows them to retrieve information quickly with relatively little attentional effort.

• Experts' knowledge is linked to contexts for applying that knowledge.

• Experts notice features and meaningful patterns that are not noticed by novices.

• Expertise in one domain does not transfer to other domains, e.g., being a chess master does not mean the master is good at solving crossword puzzles or complex math problems.

• Even experts have varying degrees of flexibility in applying their knowledge in new situations.

Implications for Teaching:

• Being an expert on a topic does not imply ability to instruct others effectively on the topic.

• Equally important to teaching the content of a discipline (facts, definitions, and concepts) is helping trainees organize this knowledge and apply it flexibly across many contexts.

Transferring Knowledge Flexibly Across Different Contexts

Ability to transfer knowledge learned in one context to another context is non-trivial.

Key Findings:

• Skills and knowledge must be extended beyond the narrow contexts in which they are initially learned.

• Learning should be linked to conditions of applicability, i.e., learning *what* should be linked to learning *when* the *what* can be applied.

• All new learning depends on previous learning. Students come to the classroom with preconceptions, and if their preconceptions are not engaged, students may fail to grasp new concepts and information that are being taught. Engaging in this context means identifying preconceptions, and, when preconceptions are misconceptions, actively helping students construct appropriate understanding based on scientific principles.

• Learning by rote rarely transfers; learning in the context of tying material to underlying principles is more effective.

• The more you know about a topic the easier it is to learn more about that topic.

Implications for Teaching:

• Help students identify appropriate contexts and conditions for application of different concepts and strategies.

• Probe often for students' preconceptions during instruction. When misconceptions that interfere with understanding scientific concepts are identified, engage the student to help her or him reconstruct appropriate understanding. Providing the right answer does not suffice in helping students overcome misconceptions.

• Link all teaching and learning to major concepts or principles in the discipline.

Designing Learning Environments

The design of learning environments is linked to issues that are important in the processes of learning, transfer, and competent performance. Those processes, in turn, are affected by the degree to which learning environments are *learner centered*, *knowledge centered*, *assessment centered*, and *community centered*.

Learner Centered:

• Learners use their current knowledge to construct new knowledge. Thus, what they know or believe at the moment affects how they interpret new information; sometimes learners' current knowledge hampers new learning, sometimes it supports learning. Effective instruction must take into account what learners bring to the classroom. Active engagement in learning supports the construction of knowledge.

• Learners should be assisted in developing *metacognitive* strategies. Metacognition refers to people's abilities to monitor their own level of understanding and decide when it is not adequate. Transfer can be improved by helping students become more aware of themselves as learners who actively monitor their learning and performance strategies.

• Learners learn more efficiently and effectively when they are provided with feedback to help them monitor progress. *Deliberate practice* refers to engagement in educational activities that include active monitoring of one's learning. For example, when left on their own to do homework in the physical sciences, students often practice the wrong habits (e.g., equation finding and manipulating), thereby reinforcing such habits. Instead, students need to be given opportunities to practice skilled problem solving and provided with both feedback and support to ensure progress.

Knowledge Centered:

• Instruction should begin with students' current knowledge and skills, rather than assuming students are blank slates ready to absorb knowledge. Emphasis on how knowledge is organized will help to promote this goal.

• Instruction should help students organize knowledge in ways that are efficient for recall and for application in solving problems.

• Instruction should focus on helping students gain deep understanding of the major concepts and principles, rather than acquisition of disconnected facts and skills.

Assessment Centered:

• Formative assessment (assessment done during the course of instruction to monitor students' progress and to help shape instruction) is pivotal for providing feedback to students so that they can revise and improve the quality of their thinking. This should be done continuously, but not intrusively, as a part of instruction.

• Formative assessment strategies should be developed that make students' thinking visible to the instructor, the learner, and other classmates.

• Summative assessments (assessment done at the end of instruction for such purposes as assigning grades or evaluating competence) should reflect the knowledge, concepts, principles, and problem solving & lab skills of the discipline considered crucial by experts.

• Students should learn how to assess their own work and that of peers.

Community Centered:

• Learners are embedded in social contexts. If they are going to make effective use of their prior knowledge, they need to be encouraged to relate the origins of their learning to school-based concepts.

• Students spend only 14% of their time in school, but 53% of their waking hours out of school. It is important to help students see the relevance of their school-based learning to non-school contexts and problem solving.

• Communities of practice need to be encouraged. Local leaders and practitioners can facilitate community-centered learning through internships, class participation, and site visits to illustrate learning and problem solving in the workplace.

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