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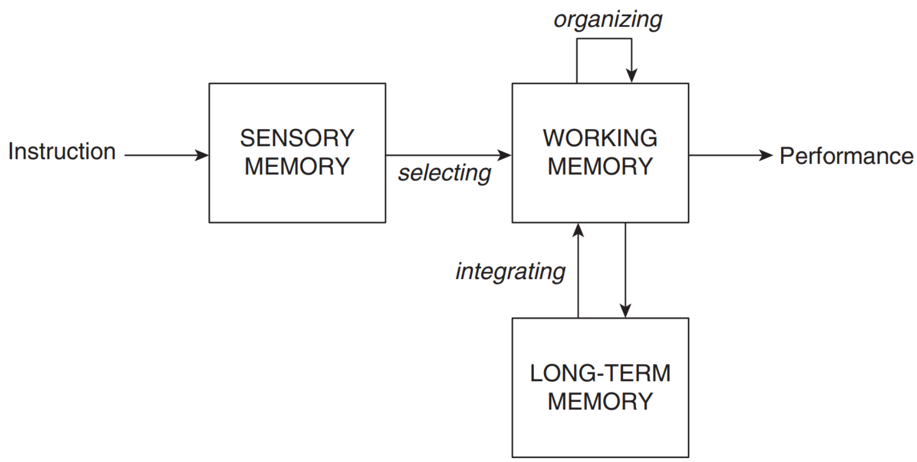
Generative Learning Theory

Generative Learning Theory (GLT) emphasizes the active role of learners in making sense of new information by integrating it with their existing knowledge. This theory suggests that learning is most effective when learners engage in activities that promote understanding and application of the material.

Through an evaluation of existing research, Fiorella and Mayer (2015) identified eight **Generative Learning Activities (GLAs)** that enhance learning:

1. Summarizing
2. Mapping
3. Drawing
4. Imagining
5. Self-testing
6. Self-explaining
7. Teaching
8. Enacting

GLAs have three characteristics in common: they require students to **select** specific information, **organize** it, then **integrate** it with their existing knowledge.



GLAs also have **boundary conditions**. These refer to the specific circumstances under which GLAs are most effective or may not work as intended. For example, the effectiveness of a GLA can depend on factors such as the learner's prior knowledge, the complexity of the materials, the context in which the learning occurs, and the age of the learner.

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Fiorella's 2023 research further organizes GLAs into three categories ("sense-making modes"): **explaining**, **visualizing**, and **enacting.** Explaining *generalizes* one's knowledge, visualizing *organizes* one's knowledge, and enacting *simulates* one knowledge.

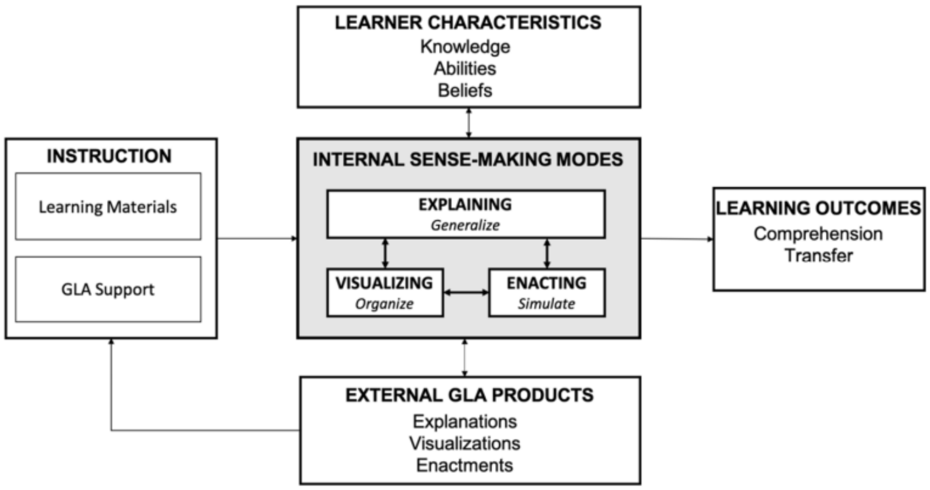

Fig. 1 Generative sense-making framework

Design Considerations

- Generative Learning Activities (GLAs), as appropriate to the grade-level and content, should be used throughout K-5 Integrated content areas.
- Boundary conditions should be considered when introducing GLAs. For example, boundary conditions for the use of summary are that students must have prior knowledge of the topic and should have received instruction in the process of summarizing. Related to cognitive load theory, if students have inadequate background knowledge or have not received explicit instruction in how to summarize a text, the extraneous load of the task may be too high, resulting in an inability for students to develop the necessary schema (germane load) because of the learning task.

References and Resources

Learning as a Generative Activity: Eight Learning Strategies that Promote Understanding (Fiorella & Mayer, 2015)

Book: Learning as a Generative Activity (Fiorella & Mayer, 2015)

Making Sense of Generative Learning (Fiorella, 2023)

Generative Learning: Which Strategies for What Age? (Brod, 2020)

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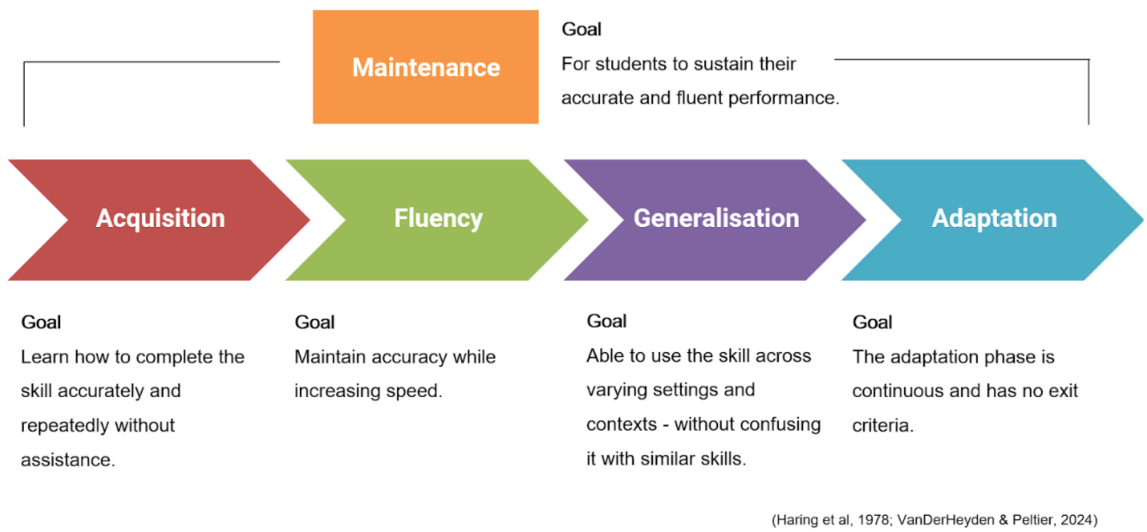
The Instructional Hierarchy

The **instructional hierarchy** outlines four stages of learning: **acquisition**, **fluency**, **generalization**, and **adaptation**. **Maintenance** refers to the ongoing practice and reinforcement of skills to ensure they are retained over time. Maintenance is related to retrieval and spaced practice as well as application in various contexts.



Depending on the stage of the hierarchy a learner is in, teachers (and materials) need to match a given stage with appropriate strategies. A summary of matching learning stages with effective strategies from Haring, et al., (1978) can be found here.

Design Considerations

- The instructional hierarchy should always be considered in the design of learning tasks for students in all content areas.
- Appropriate instructional tasks and activities must be matched to the stage where students are in the instructional hierarchy.
- Minimally guided instruction (such as discovery learning, problem-based learning, etc.) is inappropriate for task design in the initial stages of the hierarchy.
- Tier 2/supplemental materials must be developed to support students with rapid acquisition and fluency of skills required for grade-level success.
- The foundation of the upper levels of the hierarchy is the lower levels of the hierarchy. Students should not be expected to complete tasks related to generalization and adaptation until they have had adequate practice in the acquisition and fluency phases.

- When developing tasks for the “What I Need (WIN) Time”/Integrated Project Time component of the K-5 Integrated structure, consideration should be given to activities for students who need additional support with acquisition and fluency, as well as those who are ready for generalization, adaptation, or maintenance activities.

References and Resources

Effective Math Interventions: A Guide to Improving Whole-Number Knowledge (Codding, Volpe, & Poncy, 2017)

The Instructional Hierarchy: Linking Stages of Learning to Effective Instructional Techniques

Using the Instructional Level as a Criterion to Target Reading Interventions (Parker & Burns, 2014)

Research Brief: Matching Interventions to Student Learning Stages

Why so many students can’t master math: An interview with Amanda VanDerHeyden

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Rosenshine's Principles of Instruction

Rosenshine's Principles of Instruction (2012) are a set of research-based principles from three sources: 1) research in cognitive science, 2) research on master teachers, and 3) research on cognitive supports. These principles are:

1. **Begin with a review of previous learning**: Start lessons by reviewing prior knowledge to reinforce learning and connect new information.
2. **Present new material in small steps**: Break down complex information into manageable chunks to avoid overwhelming students.
3. **Ask questions**: Frequently ask questions to check for understanding and keep students engaged.
4. **Provide models**: Use examples and demonstrations to illustrate concepts and procedures.
5. **Guide student practice**: Offer support and feedback as students practice new skills.
6. **Check for understanding**: Regularly assess comprehension to ensure students are grasping the material.
7. **Obtain a high success rate**: Aim for a high level of student success during practice to build confidence and competence.
8. **Provide scaffolding**: Gradually reduce support as students become more proficient.
9. **Require and monitor independent practice**: Encourage students to practice independently while monitoring their progress.
10. **Engage students in weekly and monthly reviews**: Conduct regular reviews to reinforce learning and aid retention.

Design Considerations

The Principles of Instruction are an easy-to-understand summary of many of the topics already discussed, including Cognitive Load Theory, retrieval and spaced practice, metacognition, etc., and the design of the materials should align with these principles.

References and Resources

Principles of Instruction (Rosenshine, 2012)

Additional Resources

This section contains additional concepts, research, and resources that should influence our approach to the design of the K-5 Integrated product.

Reading/Language Arts Research-Based Instructional Strategies (RBIS)

The RLA RBIS form the research base for work done in reading/language arts at the agency. The RLA Instructional Materials Review and Approval (IMRA) Quality Rubrics are also built on these concepts.

The RLA RBIS are:

1. Direct, explicit instruction in foundational literacy skills
2. Knowledge coherence
3. Text quality and complexity
4. Evidence-based tasks and responses

TEA has in-depth training materials on each of these concepts to support with alignment and coherence across agency initiatives.

Mathematics Research-Based Instructional Strategies (RBIS)

Like the RLA RBIS, the Math RBIS are the research base for work done in mathematics at the agency. The Mathematics IMRA Quality Rubrics are built on these concepts.

The Math RBIS are:

1. Balance of conceptual and procedural understanding
2. Depth of key concepts
3. Coherence of key concepts
4. Productive struggle

TEA has in-depth training materials on each of these concepts to support with alignment and coherence across agency initiatives.

The Importance of Fluency and Memorization in Math Education

Fluency and automaticity play a foundational role in the development of higher-order thinking skills and problem solving. This paper reviews the importance of memorization and automaticity in math performance.

Designing Mathematics Standards in Agreement with Science (Hartman, et al., 2023)

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Instructional strategies like "Cover-Copy-Compare" and taped problems should be incorporated to build fluency with math facts.

Cover-Copy-Compare (Intervention Central)

Taped Problems

Direct Instruction vs. Inquiry in Science Education

This set of papers (as well as the related podcast with Paul Kirschner) highlights the gap between educational psychology research and common educational practices which "[promote] inquiry and exploration as a pedagogy." There is much to consider here in our approach to science instruction in the K-5 Integrated materials.

There is an Evidence Crisis in Science Educational Policy (Zhang, Kirschner, Cobern, and Sweller, 2022)

Let's talk evidence – The case for combining inquiry-based and direct instruction (De Jong, et al., 2023)

Response to De Jong et al.'s (2023) paper "Let's talk evidence – The case for combining inquiry-based and direct instruction" (Sweller, et al., 2024)

Reading in Science and Social Studies

Both resources linked below provide research and models of how to integrate reading in science and social studies to improve student achievement.

The74: Teaching Science and Reading Together Yields Double Benefits for Learning

The MORE Curriculum

Minimal Guidance During Instruction

This 2006 article takes on the problems of a discovery-based approach to instruction in the context of what we understand about human cognitive architecture. This has important connections to Cognitive Load Theory as well as the Instructional Hierarchy and how we design learning tasks for the K-5 Integrated product.

Why Minimal Guidance During Instruction Does Not Work: An Analysis of the Failure of Constructivist, Discovery, Problem-Based, Experiential, and Inquiry-Based Teaching (Kirschner & Clark, 2006)

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Developing Curriculum for Deep Thinking

This multi-author text explains why shared knowledge in early grades is key to producing competent citizens.

Developing Curriculum for Deep Thinking: The Knowledge Revival (Surma, et al., 2025)

Link to Resource Folder

Shared folder with all linked PDFs