Training Writing Skills: A Cognitive Developmental Perspective

Ronald T. Kellogg
Saint Louis University

EARLI SigWriting 2006
September 20, 2006
Antwerp

Writing Extended Texts

• Learning to write is a slow cultural process involving decades of skill development in contrast with the biologically prepared, rapid acquisition of spoken language.
• Writing requires orthographic as well as phonological coding.
• Writing draws on three major cognitive systems: memory, thinking, and language.
Figure 4.1. Conceptual knowledge (From Alexander, Schallert, & Hare, 1991. Copyright © 1991 by the American Educational Research Association; Reprinted by permission).
Knowledge Use Principle

- Availability of knowledge in long-term memory is a necessary but insufficient condition for good writing.
- Accessibility and creative application of knowledge through working memory is also necessary.
- Without training, knowledge too often remains inert during composition.
Knowledge Use Themes

- Using knowledge requires maintaining and manipulating multiple representations in working memory.
  - Working memory constrains advancement from knowledge-telling to knowledge-transforming to knowledge-crafting.

- Extending the 10 Year Training Rule to Writing Expertise
  - Acquiring expertise in complex cognitive domains requires a minimum of 10 years of dedicated training and in writing perhaps much longer.

- Executive attention must be available to coordinate writing processes for advanced stages of writing skill.
  - Only maturation, domain-specific learning, or process training can achieve this end.

- Training as well as Instruction are Necessary
  - Deliberate Practice
  - Cognitive Apprenticeship

Overview

- Stages of Expertise
- Working Memory Constrains Development
- Implications for Writing Education
  - Maturation
  - Domain-Specific Learning
  - Process Training
- Training Methods
  - Deliberate Practice
  - Cognitive Apprenticeship
- Paradoxes & Conclusions
Overview

- Stages of Expertise
- Writing Memory Constraints Development
- Implications for Writing Instruction
  - Maturation
  - Domain-Specific Learning
  - Process Training
- Training Methods
  - Deliberate Practice
  - Cognitive Apprenticeship
- Paradoxes & Conclusions

---

- Knowledge-Telling
  - Planning limited to idea retrieval
  - Limited interaction of planning and translating
  - No reviewing

- Knowledge-Transforming
  - Interaction of planning, translating, and reviewing
  - Reviewing primarily of author’s representation
  - Revise text so it corresponds to author’s representation

- Knowledge-Crafting
  - Interaction of planning, translating, and reviewing
  - Reviewing of both author and text representations
  - Revise text so it corresponds to the reader’s representation, as imagined by the author.

---

Years of Practice

Writing Skill

Author

Text

Reader

10

20
Knowledge-Telling

By age 4, child has a theory of mind and understands that a reader’s ideas may differ from the author’s ideas.

Even so, the focus is on retrieval and production of the author’s ideas.
Child’s Verbal Protocol Reveals “Retrieve and Write”
from Bereiter & Scardamalia (1978)

<table>
<thead>
<tr>
<th>Verbal Protocol</th>
<th>Text Produced</th>
</tr>
</thead>
<tbody>
<tr>
<td>“My dad can swim better than us all”</td>
<td>“My dad is the swimmer.”</td>
</tr>
<tr>
<td>“My mom makes me swim back and forth ten times.”</td>
<td>“My mom make’s me swim back and forth over and over.”</td>
</tr>
</tbody>
</table>

Knowledge-Transforming

Focus is on the author’s ideas and the text’s meaning.
Adult’s Verbal Protocol Reveals Thinking about Content and Rhetorical Problems from Flower & Hayes (1978)

**Verbal Protocol**
- “So, if I’m happy when I write a good paper, it really doesn’t matter what kind of grade I get back on it, if I’m happy with it. So, um, um, let’s see, Um, what are the—I’m thinking of, I’m trying to relate personal satisfaction between academic pressure and grades, but I’m not really sure how to do it, how to branch it.”

**Text Produced**
- “After I begin writing a paper, the grade emphasis diminishes and a higher level of personal satisfaction takes over.”

Adult’s Verbal Protocol Reveals Thinking about Content and Rhetorical Problems from Flower & Hayes (1978)

**Verbal Protocol**
- “I’m trying to think of the first sentence to start with. Um, maybe something like, personal satisfaction is the major motivating force...OK, I want to somehow get it into the academic pressures now. Um, well, may not so soon. OK. Not only do I get satisfaction from my grades, but I also get satisfaction in turning in something that is good quality.”

**Text Produced**
- “The initial motivator at the outset of writing a paper is the fact that a grade will be attached to it upon completion.”
Knowledge-Crafting
The reader’s interpretation of the text is now active, too.

Development of Reader-Centered Revision

Audience Awareness  Reader-Centered Revision

Author  Reader  Author  Text  Reader
Two Kinds of Revision
(i.e., reviewing that prompts renewed planning and translating)

- **Author-Centered Revision:**
  - seeks a correspondence between the author’s representation (i.e., what the author intends to say) and the text’s representation (i.e., what the text says to the author).

- **Reader-Centered Revision**
  - seeks in addition a correspondence between the author’s representation and the reader’s representation (i.e., what the text says to the reader as imagined by the author).
  - Bazerman (1988) Shaping Written Knowledge

Knowledge-Crafting

- The author fictionalizes the audience for the text to understand its meaning from the readers’ point of view.
  - “...the writer must anticipate all the different senses in which any statement can be interpreted and correspondingly clarify meaning and to cover it suitably.”
  - Ong (1978) Literacy and Orality in Our Times

- What knowledge can the author assume the reader already knows?
  - “This knowledge is one of the things that separates the beginning graduate student or even the brilliant undergraduate from the mature scholar.”
  - Ong (1975) The Writer’s Audience is Always a Fiction
Knowledge Crafting

- Kirsch (1990): Compositions of writing instructors and doctoral candidates in rhetoric and literature show reader-based revision.

<table>
<thead>
<tr>
<th>Years of Practice</th>
<th>Writing Skill</th>
<th>Author</th>
<th>Text</th>
<th>Reader</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>Knowledge-Telling</td>
<td>• Planning limited to idea retrieval&lt;br&gt;• Limited interaction of planning and translating&lt;br&gt;• No reviewing</td>
<td>Author</td>
<td>Text</td>
</tr>
<tr>
<td>20</td>
<td>Knowledge-Transforming</td>
<td>• Interaction of planning, translating, and reviewing&lt;br&gt;• Reviewing primarily of author’s representation&lt;br&gt;• Revise text so it corresponds to author’s representation</td>
<td>Author</td>
<td>Text</td>
</tr>
<tr>
<td></td>
<td>Knowledge-Crafting</td>
<td>• Interaction of planning, translating, and reviewing&lt;br&gt;• Reviewing of both author and text representations&lt;br&gt;• Revise text so it corresponds to the reader’s representation, as imagined by the author</td>
<td>Author</td>
<td>Reader</td>
</tr>
</tbody>
</table>

- Knowledge-Telling: Planning limited to idea retrieval, limited interaction of planning and translating, no reviewing.
- Knowledge-Transforming: Interaction of planning, translating, and reviewing, reviewing primarily of author’s representation, revise text so it corresponds to author’s representation.
- Knowledge-Crafting: Interaction of planning, translating, and reviewing, reviewing of both author and text representations, revise text so it corresponds to the reader’s representation, as imagined by the author.
Typical Time Course
Decade per stage
Overlap indicates individual variation

- Knowledge Telling
  06-16 years
- Knowledge Transforming
  14-24 years
- Knowledge Crafting
  22-32 years

Note: Most writers stop training and do not attain the third stage characteristic of professionals.

Expert Writers Can:

- represent and manipulate the author’s ideas, the text’s meaning, and the imagined reader’s interpretation of the text.
- coordinate complex interactions of planning ideas, text generation, and reviewing of ideas and text.
  - both imply a high degree of self-regulation of cognition, emotion, and behavior.
Overview

- Stages of Expertise
- **Working Memory Constrains Development**
- Implications for Writing Education
  - Maturation
  - Domain-Specific Learning
  - Process Training
- Training Methods
  - Deliberate Practice
  - Cognitive Apprenticeship
- Paradoxes & Conclusions
Sentence Production Demands: Verbal Working Memory

- Orthographic as well as phonological representations must be activated for written spelling.
  - Bonin, Fayol, & Gombert (1997)

- Verbal WM is necessary to maintain representations during grammatical, phonological, and orthographic encoding.
  - Levy & Marek (1999)
  - Chenoweth & Hayes (2001)
Sentence Production Demands: Visual-Spatial Working Memory

- Visual WM is invoked by optional needs in planning content, such as imaging concrete nouns.
  - Sadoski, Kealy, Paivio, & Goetz (1997)

- Similarly, spatial WM has a specific role in generating ideas during planning

Executive Function in Writing

Measuring Executive Attention

- Interference in secondary RT indexes demands of writing processes on executive attention.
  - Piolat, Olive, & Kellogg (2004)
Measuring Executive Attention

• Interference in secondary RT indexes demands of writing processes on executive attention.
  - Piolat, Olive, & Kellogg (2004)

• Concurrent decisions require executive attention and disrupt sentence production.
  - Kalsbeek & Sykes (1967)
Distract of Executive Attention from Sentence Generation by a Primary Concurrent Task

- Causes a reduction in sentence length.
  - Ransdell, Levy, & Kellogg (2002)

- Causes a disruption in grammatical encoding (e.g., subject-verb agreement).
  - Fayol, Largy & Lamaire (1994)

- Causes a slowing in word production.
  - Ferreira & Pashler (2002)

WM as a Constraint on Cognitive Development

- Neo-Piagetian accounts assume working memory constrains cognitive development and the production of coherent texts.
  - Pascual-Leone (1970)
  - Scinto (1995)

- Rapid emergence of executive strategies (e.g., systematic search and subvocal rehearsal) between ages 6-10 maps and growth in executive control in adolescence depends on working memory increases.
  - Case (1995)
  - Kuhn (2006)
WM as a Constraint on Writing Development

- The emergence of planning requires the mastery of handwriting and spelling

- Planning, generating, and reviewing are each limited by individual differences and age differences in WM capacity
  - McCutchen (1996)
  - Ransdell & Levy (1996)

- Self-regulation of planning, translating, and reviewing requires mastery of handwriting and spelling and age-related growth in WM capacity
  - Graham & Harris (2000)
  - McCutchen (1996)

Overview

- Stages of Expertise
- Working Memory Constrains Development
- Implications for Writing Education
  - Maturation
  - Domain-Specific Learning
  - Process Training
- Training Methods
  - Deliberate Practice
  - Cognitive Apprenticeship
- Paradoxes & Conclusions
Ways to Help WM Functioning

- Maturation of frontal lobes and associated executive functions.
- Development of long-term working memory (i.e., accessible domain-specific knowledge)
- Reduction of the momentary demands on executive attention.

Prefrontal Cortical Development

- Prefrontal cortical regions associated with the WM central executive are not fully developed until early adulthood.
  - Kuhn (2006)
- *In vivo* evidence of delayed brain maturation in frontal regions can be seen in MRI comparisons of adolescents (ages 12-16) and young adults (ages 23-30).
  - Sowell, Thompson, Holmes, Jernigan, Toga (1999)
Automatic Retrieval from Long-Term Memory reduces Working Memory Overload

- Expertise provides long-term working memory reducing the load on the traditional short-term stores and central executive.
  - Ericsson & Kintsch (1995)
- Domain-specific expertise on the writing topic allows rapid, effortless retrieval of knowledge as it is needed during text production.
  - McCutchen (2000)
  - Kellogg (2001)
Reducing the Momentary Demands

- Use strategies that funnel more effort to one process at a given moment in time. Examples include:
  - Outline during prewriting to focus text generation during a first, relatively polished, draft.
    - Kellogg (1988; 1990)
  - Prepare unorganized notes or sentences as a rough, first draft that are then set aside in preparing a revised draft.
    - Galbraith & Torrance (2004)
Focusing Effort with Strategies
Data from Galbraith & Torrance (2004)

Reducing the Momentary Demands

- Achieve relative automaticity by reducing the cognitive effort of restricted subcomponents.
  - Proceduralize knowledge (Anderson, 1983)
  - Retrieve rather than compute (Logan, 1988)

Examples include:
- transcription (handwriting and spelling mastery)
  - McCutchen (1996)
  - Bourdin & Fayol (2002)
- revision of subject-verb agreement errors (slow effortful algorithm in young children changes to rapid automatic check in undergraduates).
  - Fayol, Hupet, & Largy (1999)
Overview

- Stages of Expertise
- Working Memory Constrains Development
- Implications for Writing Instruction
  - Maturation
  - Domain-Specific Learning
  - Process Training
- Training Methods
  - Deliberate Practice
  - Cognitive Apprenticeship
- Paradoxes & Conclusions

Deliberate Practice
Ericsson, Krampe, & Tesch-Romer (1993)

1) Effortful exertion to improve performance.
2) Intrinsic motivation to engage in the task.
3) Practice tasks that within reach of individual’s current level of ability.
4) Feedback that provides knowledge of results.
5) High levels of repetition.
Deliberate Practice in Novelists


- Norman Mailer (2003, p. 14): “I learned to write by writing. As I once calculated, I must have written more than a half a million words before I came to the *Naked and the Dead*.”
Deliberate Practice in Writing Intensive University Courses
Data from Johnstone, Ashbaugh & Warfield (2002)
Designing Effective Practice: Massed vs. Spaced

- Massed practiced can exhaust and block a writer. Professionals use spaced, highly consistent practice.
  - Boice (1985)
  - Kellogg (in press)
- Blocked practice helps performance during acquisition, but harms long-term skill retention.
  - Schmidt & Bjork (1992)

Handwriting Skill Acquisition
Data from Ste-Marie, Clark, Findlay, & Latimer (2004)

![Graph showing Transfer Task Performance After a Retention Interval]

- Time Score
- 20 min. 24 hour
- Blocked vs. Random

Retention Interval
Designing Effective Practice: Tailored and Timely Feedback

• Providing individually tailored feedback is highly labor intensive and subject to poor reliability.
  o Freedman & Calfee (1983)

• Delay of feedback is often measured in days or even weeks.

Automated Essay Scoring

e-rater and Intelligent Essay Assessor

• Potential to provide reliable, immediate, and individualized feedback while reducing grading burden.

• Validity and acceptance of computerized grading is still in question.
  o Ericsson & Haswell (2005)
Cognitive Apprenticeship
Vygotsky (1978)
Rogoff (1990)

1) Mentor-guided participation in an organized cultural activity.
2) Zone of proximal development-gap between current and potential performance achieved under guidance.
3) Learning precedes development-the environment induces and supports students to learn beyond their current development.
4) Learning by observation of models, with progressively more adult-like performance.

Psychology and the Teaching of Writing in 8000 and Some Words (Rijlaarsdam et al., 2005)
Data from Couzijn & Rijlaarsdam (1996).

Figure 9. Pre- and post-test effect sizes for four experimental conditions.
Environments for Active Learning: A Vygotskian Perspective
Hillocks (1986; 1995)

- Support students in learning strategies for solving content and rhetorical problems.
- Necessity of engaging students in writing tasks instead of listening to lectures.
- Guidance from teachers and more capable peers raises performance beyond what individuals can do on their own.

Figure A.1 Mode of Instruction: Experimental/Control Effects

- All treatments: $R^2 = 0.36$
- Vygotsianal: $p = 0.01$
- Remedial: $p = 0.19$
- Individualized: $p = 0.17$
- Environmental: $p = 0.44$
Self-Regulated Learning: From Teaching to Self-Reflected Practice
Schunk & Zimmerman (1997)

1) Observation: Watching model’s actions.
2) Emulation: Enact model’s performance.
3) Self-control: Self-directed practice to achieve automaticity.
4) Self-regulation: Adapt performance to changes in internal and external conditions.

Psychology and the Teaching of Writing in 8000 and Some Words
Rijlaarsdam et al. (2005)

Figure 12. Effect sizes model conditions (upper panel) in combination with practice conditions (lower panel). Data adapted from Zimmerman and Kitsantas (2002).
Overview

• Stages of Expertise
• Working Memory Constrains Development
• Implications for Writing Education
  ➢ Maturation
  ➢ Domain-Specific Learning
  ➢ Process Training
• Training Methods
  ➢ Deliberate Practice
  ➢ Cognitive Apprenticeship
• Paradoxes & Conclusions

Summary and Paradoxes

• Executive attention must be available to coordinate writing processes for advanced stages of writing skill.
• Only maturation, domain-specific learning, or process training can achieve this end.
• Paradox 1: literary precocity.
• Paradox 2: older professional writers.
The Paradox of Precocity in Writing Skill

• Geoffrey, a prolific 5-year old writer, challenges the thesis that executive functioning is necessary for writing.
  o Edmunds & Noel (2003)

• “Geoffrey had, at a very early age, achieved...knowledge-transforming wherein he had actively and constructively transformed the content of the source information by making novel connections and a novel story.

Possible Resolution

• Geoffrey’s text revealed no editing, as confirmed by Geoffrey and by his mother. Rather the text was completely planned and generated in a “rush of creative activity.”

• Precocity in writing is extremely rare compared with prodigies in mathematics, music, and other domains.
  o Feldman (1993)
The Paradox of Cognitive Aging and Writing Skill

- Working memory declines markedly in middle aged and older adults.
- Then, why do writers maintain or even improve their skill of knowledge crafting with advanced age?
Possible Resolution

- Deliberate practice continues to reduce the effort of writing processes.
- Domain-specific expertise on a topic allows rapid, automatic retrieval from long-term memory on a just-in-time basis (i.e., long-term working memory). Note crystallized intelligence using long-term memory persists in old age.

Conclusions

- Writing involves multiple representations and processes, with capacity limitations in working memory constraining skill development.
- Advanced writing skills require training as well as instruction so that executive attention can coordinate writing processes.
- Principles of deliberate practice and cognitive apprenticeship offer means to train writers to use their knowledge effectively during composition.