Literacy and Task Complexity in the Self-Management of Diabetes

Linda S. Gottfredson
School of Education
University of Delaware
Newark, DE 19716 USA


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April 22, 2009
Most Crucial Points Today

1. Health literacy = functional literacy
   - Doing something practical, not just knowing about it
   - Domain general capability, not content specific

2. Task performance depends on:
   a. Cognitive resources of patient
      - Rests on general capacity to learn, reason, solve problems
      - Huge differences across individuals
   b. Cognitive load of task
      - Rests on complexity of information processing
      - Huge differences across tasks
   c. Quality of instruction

3. Diabetes self-management is complex, lifelong job
   - Fluid constellation of tasks
   - Requires independent judgment
Literacy: How many? How different?

Functional literacy?

- Work
- Financial
- Health
- Others

Reading

Listening

Prose

Document

Quantitative
“Literacy” is general
- not reading per se, but comprehension
- not content specific
- not modality specific

“Literacy” ≈ “trainability” = AFQT (Armed Forces Qualification Test)
- Can teach specific knowledge & skills
- Cannot teach “literacy”

Literacy is a general ability:
- “complex information processing skills”
- “verbal comprehension & reasoning”
- “ability to understand, analyze, evaluate”

- “children and young adults have adequate abilities for basic tasks, but are poor problem solvers…..Skills can be applied in isolation but not in combination” (p. 28).
Common Conclusion

“Literacy” is ability to process information effectively & efficiently

- Highly general ability to learn, reason, solve problems, think abstractly
- Not knowledge per se, but ability to accumulate and apply it
- Peaks in early adulthood, then steadily declines
So, Now Order From the Confusion

General Information-processing capability (e.g. to learn & reason, spot & solve problems)

Effective self-maintenance or "Functional literacy"

Any uptake modality

Reading

Listening

Any info format

Prose

Document

Quantitative

Any content domain

Financial

Health

Others

Literacy is "generalizable"

Info barrier if not native speaker!
Tests of functional literacy

- Individuals use written info to accomplish a task
- Items simulate everyday tasks with familiar materials
Quiz: What HALS literacy level is this?

(HALS=Health Activities Literacy Scale, see “Literacy & Health in America,” 2004)

**Pediatric Dosage Chart**

<table>
<thead>
<tr>
<th>Age</th>
<th>Approximate Weight Range*</th>
<th>Drops</th>
<th>Syrup</th>
<th>Chewables 80 mg</th>
<th>Chewables 160 mg</th>
</tr>
</thead>
<tbody>
<tr>
<td>† Under 3 mo</td>
<td>Under 13 lb</td>
<td>½ dropper</td>
<td>⅛ tsp</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>† 3 to 9 mo</td>
<td>13-20 lb</td>
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<td>½ tsp</td>
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<td>—</td>
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<td>4 to 5 yr</td>
<td>36-43 lb</td>
<td>1⅛ dropper</td>
<td>⅛ tsp</td>
<td>3 tablets</td>
<td>1½ tablets</td>
</tr>
<tr>
<td>6 to 8 yr</td>
<td>44-62 lb</td>
<td>2 dropper</td>
<td>2 tsp</td>
<td>4 tablets</td>
<td>2 tablets</td>
</tr>
<tr>
<td>9 to 10 yr</td>
<td>63-79 lb</td>
<td>2½ dropper</td>
<td>3 tsp</td>
<td>5 tablets</td>
<td>2½ tablets</td>
</tr>
<tr>
<td>11 yr</td>
<td>80-89 lb</td>
<td>3 dropper</td>
<td>4 tsp</td>
<td>6 tablets</td>
<td>3 tablets</td>
</tr>
<tr>
<td>12 yr and older</td>
<td>90 lb &amp; over</td>
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<td>3-4 tablets</td>
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</tbody>
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* Consult with physician before administering to children under the age of 2 years. Dosage may be given every 4 hours as needed but not more than 5 times daily.

How Supplied:
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The weight categories in this chart are designed to approximate effective dose ranges of 10-15 milligrams per kilogram.

Current Pediatric Diagnosis and Treatment, 8th ed. CI Kempe and NN Silver, ed. Lange Medical Publications: 1986, p. 1079

What % of people could use it?
Could format be simplified?
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<tr>
<td>Under 3 mo</td>
<td>Under 13 lb</td>
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<td></td>
<td></td>
</tr>
<tr>
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<td>13-20 lb</td>
<td>1 dropper</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10 to 24 mo</td>
<td>21-26 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 to 3 yrs</td>
<td>27-30 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4 to 6 yrs</td>
<td>31-35 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7 to 12 yrs</td>
<td>36-50 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13 yrs &amp; over</td>
<td>&gt;50 lb</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

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Trick question: No task was specified.

Key point: Literacy means doing something, not just reading or knowing about it.
Task #1—Underline sentence saying how often to administer medication

Pediatric Dosage Chart

Drops, Syrup, & Chewables

<table>
<thead>
<tr>
<th>Age</th>
<th>Approximate Weight Range*</th>
<th>Drops</th>
<th>Syrup</th>
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<td>1½ dropper</td>
<td>¾ tsp</td>
<td>—</td>
<td>—</td>
</tr>
<tr>
<td>2 to 3 yr</td>
<td>27-35 lb</td>
<td>2 droppers</td>
<td>1 tsp</td>
<td>2 tablets</td>
<td>—</td>
</tr>
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<td>36-43 lb</td>
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<td>1½ tablets</td>
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</table>

* Consult with physician before administering to children under the age of 2 years.

Dosage may be given every 4 hours as needed but not more than 5 times daily.

Caution! Could train them do this task, but not all possible tasks like it

% US adults routinely functioning below Level 2?

20%

HALS LEVELS:

<table>
<thead>
<tr>
<th>Levels:</th>
<th>Below Level 1</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
<th>Level 4</th>
<th>Level 5</th>
</tr>
</thead>
<tbody>
<tr>
<td>HALS SCORES:</td>
<td>175</td>
<td>225</td>
<td>275</td>
<td>325</td>
<td>375</td>
<td>500</td>
</tr>
</tbody>
</table>

#1

Mean = 272

239
Task #2—How much syrup (one dose) for 10-year-old who weighs 50 pounds?

<table>
<thead>
<tr>
<th>Age</th>
<th>Approximate Weight Range*</th>
<th>Drops</th>
<th>Syrup (80 mg)</th>
<th>Dosage</th>
<th>Chewables (160 mg)</th>
</tr>
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<tbody>
<tr>
<td>† Under 3 mo</td>
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<td>4 tablets</td>
<td>2 tablets</td>
</tr>
<tr>
<td>9 to 10 yr</td>
<td>50-70 lb</td>
<td>3 tsp</td>
<td>6 tablets</td>
<td>3 tablets</td>
</tr>
<tr>
<td>11 yr</td>
<td>60-89 lb</td>
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% US adults routinely functioning below Level 4? 

82%

---

**HALS Levels and Scores**

<table>
<thead>
<tr>
<th>HALS Levels:</th>
<th>Below Level 1</th>
<th>Level 1</th>
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<th>Level 3</th>
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- Spot & reconcile conflicting info
- Inference from ambiguous info
- Multiple features to match
- Conditional (if-then)
#3—Your child is 11 years old and weighs 85 pounds. How many 80 mg tablets can you give in 24-hr period?

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<tr>
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<th>Approximate Weight Range*</th>
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© 1988, Bristol-Myers Pharmaceutical and Nutritional Group.
#3—Your child is 11 years old and weighs 85 pounds. How many 80 mg tablets can you give in 24-hr period?

- Multiple features to match
- Two-step task
- Infer proper math operation
- Select proper numbers to use
- Ignore the most obvious but incorrect number
- Calculate the result

% US adults routinely functioning below Level 5? 99%
So, The Answers Are:

1. What % of people could use it?
   - Depends on what they have to do with it (the graphic is just a job aid)
   - More complex tasks increase cognitive load
   - People differ in when load exceeds their capacity
   - Shockingly low %s for “simple” tasks

2. Could format be simplified?
   - Not clear how (essential info can be inherently complex)
   - Most cognitive load created by complexity of tasks performed

---

**Pediatric Dosage Chart**

<table>
<thead>
<tr>
<th></th>
<th>11 yr</th>
<th>80-89 lb</th>
<th>—</th>
<th>3 tsp</th>
<th>6 tablets</th>
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# Item difficulty rests on “processing complexity”

Sample components (NALS & HAALS)

<table>
<thead>
<tr>
<th>Prose items</th>
<th>Pts</th>
<th>Document</th>
<th>Pts</th>
<th>Quantitative</th>
<th>Pts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Need only locate in text</td>
<td>+1</td>
<td>Need only locate in text</td>
<td>+1</td>
<td>Numbers in row/column format</td>
<td>+0</td>
</tr>
<tr>
<td>Must cycle through text</td>
<td>+2</td>
<td>Must cycle through text</td>
<td>+2</td>
<td>Numbers not in rows/columns</td>
<td>+2</td>
</tr>
<tr>
<td>Must integrate as searching</td>
<td>+3</td>
<td>Must integrate as searching</td>
<td>+3</td>
<td>Numbers adjacent</td>
<td>+0</td>
</tr>
<tr>
<td>Must generate as searching</td>
<td>+5</td>
<td>Must generate as searching</td>
<td>+5</td>
<td>Numbers not adjacent</td>
<td>+1</td>
</tr>
<tr>
<td>1 phrase to search on</td>
<td>+0</td>
<td>1 feature to match</td>
<td>+0</td>
<td>Labels/amts identified c/o search</td>
<td>+0</td>
</tr>
<tr>
<td>2 phrases to search on</td>
<td>+1</td>
<td></td>
<td></td>
<td>Labels present, amts require search</td>
<td>+1</td>
</tr>
<tr>
<td>3 phrases to search on</td>
<td>+2</td>
<td></td>
<td></td>
<td>Labels inferred, amts require search</td>
<td>+2</td>
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<tr>
<td>4 phrases to search on</td>
<td>+3</td>
<td></td>
<td></td>
<td>Labels ambiguous</td>
<td>+4</td>
</tr>
<tr>
<td>Match is literal or synonymous</td>
<td>+0</td>
<td></td>
<td></td>
<td>Operation signaled by +, -, x, /, or states ‘add,’ ‘subtract,’ etc.</td>
<td>+0</td>
</tr>
<tr>
<td>Match requires low-level text-based inference</td>
<td>+1</td>
<td></td>
<td></td>
<td>Semantic relationship stated, e.g., ‘how much less,’ ‘calculate the difference,’ etc.</td>
<td>+1</td>
</tr>
<tr>
<td>Match requires high text-based inference</td>
<td>+3</td>
<td>Match requires both a condition &amp; low-level text-based inference</td>
<td>+2</td>
<td>Operation easily inferred; ‘how much saved,’ or ‘deduct’</td>
<td>+2</td>
</tr>
<tr>
<td>Number of responses unspecified</td>
<td>+1</td>
<td>Match requires high text-based inference</td>
<td>+3</td>
<td>Operation based on known ratios; e.g., ‘percent 0’</td>
<td>+3</td>
</tr>
</tbody>
</table>

- Abstract, not concrete
- More elements to match
- More inferences to draw
- More distracting info
- Conflicting or ambiguous info
- Operations not specified
What can practitioners do?

1. Estimate patient literacy level (cognitive capacity)

<table>
<thead>
<tr>
<th>HALS LEVELS:</th>
<th>Below Level 1</th>
<th>Level 1</th>
<th>Level 2</th>
<th>Level 3</th>
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<td>275</td>
<td>325</td>
<td>375</td>
<td>500</td>
</tr>
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</table>

   Mean = 272

One question works
Summary of learning needs by literacy level

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</tr>
</tbody>
</table>

- **Mean = 272**
- #1: 239
- #2: 329
- #3: 378

- Can gather, infer information on own
- Very explicit, structured, hands-on
- Slow, simple, concrete, one-on-one instruction
- Mastery learning, hands-on
- Learns well in college format
- Written materials & experience
### Bloom’s Famous Taxonomy for Instructional Goals: Cognitive Realm

<table>
<thead>
<tr>
<th>Bloom difficulty level</th>
<th>Sample verbs</th>
<th>Diabetes Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Remember</td>
<td>Recognize, recall, identify, retrieve</td>
<td>?</td>
</tr>
<tr>
<td>2. Understand</td>
<td>Paraphrase, summarize, compare, predict, infer</td>
<td>?</td>
</tr>
<tr>
<td>3. Apply</td>
<td>Execute familiar task, apply procedures to unfamiliar task</td>
<td>?</td>
</tr>
<tr>
<td>4. Analyze</td>
<td>Distinguish, focus, select, integrate, coord</td>
<td>?</td>
</tr>
<tr>
<td>5. Evaluate</td>
<td>Check, monitor, detect inconsistencies, judge effectiveness</td>
<td>?</td>
</tr>
<tr>
<td>6. Create</td>
<td>Hypothesize, plan, invent, devise, design</td>
<td>?</td>
</tr>
</tbody>
</table>

Key to active self-management
What can practitioners do?—cont.

1. Estimate patient literacy level (cognitive capacity)

   ?           ?           ?

   One question works

   HALS LEVELS:  Below Level 1  Level 1  Level 2  Level 3  Level 4  Level 5

2. Tailor instruction to capacity

   • Amount of scaffolding, repetition, feedback, reteaching, etc.

   Guides available

   HALS LEVELS:  Below Level 1  Level 1  Level 2  Level 3  Level 4  Level 5

3. Know complexity (cognitive load) of diabetes tasks

   Mean = 272

   #1  239  #2  329  #3  378

   Neglected

   HALS LEVELS:  Below Level 1  Level 1  Level 2  Level 3  Level 4  Level 5

   HALS SCORES:  175  225  275  325  375  500
Good patient instruction—Crucial

1. But one size doesn’t fit all
2. And never sufficient
Because diabetes is a complex job with little training or supervision. Must apply info “on the job”:
- 24 hours/day
- 7 days/week
- No vacations
- No retirement

Clinic

- Information
- Communication
- Understand, learn
- Not blank slate (misinfo)

practitioner

patient
Diabetes: Patients’ “job description”

- Learn about diabetes in general *(At “entry”)*
  - Physiological process
  - Interdependence of diet, exercise, meds
  - Symptoms & corrective action
  - Consequences of poor control

- Apply knowledge to own case *(Daily, Hourly)*
  - Implement appropriate regimen
  - Continuously monitor physical signs
  - Diagnose problems in timely manner
  - Adjust food, exercise, meds in timely and appropriate manner

- Coordinate with relevant parties *(Frequently)*
  - Negotiate changes in activities with family, friends, job
  - Enlist/capitalize on social support
  - Communicate status and needs to practitioners

- Update knowledge & adjust regimen *(Occasionally)*
  - When other chronic conditions or disabilities develop
  - When new treatments available
  - When life circumstances change

Self-management
Good performance requires good judgment*

- **IT IS NOT** mechanically following a recipe
- **IT IS** keeping a complex system under control in often unpredictable circumstances
  - Coordinate a regimen having multiple interacting elements
  - Adjust parts as needed to maintain good control of system buffeted by many other factors
  - Anticipate lag time between (in)action and system response
  - Monitor advance “hidden” indicators (blood glucose) to prevent system veering badly out of control
  - Decide appropriate type and timing of corrective action if system veering off-track
  - Monitor/control other shocks to system (infection, emotional stress)
  - Coordinate regimen with other daily activities
  - Plan ahead (meals, meds, etc.)
    - For the expected
    - For the unexpected and unpredictable
  - Prioritize conflicting demands on time and behavior

* See Gottfredson (1997, 2006)
Cognitive ability predicts performance in all jobs—but especially higher up.

More complex jobs

IQs of applicants for:
Attorney, Engineer
Teacher, Programmer
Secretary, Lab tech
Meter reader, Teller
Welder, Security guard
Packer, Custodian

Criterion validity (corrected)
80
100
120
MD

Diabetes?
Common building blocks of job complexity
(add to cognitive load, raise accident rates)

- **Individual tasks**
  - Abstract, unseen processes; cause-effect relations
  - Incomplete or conflicting information; much information to integrate; relevance unclear
  - Inferences required; operations not specified
  - Ambiguous, uncertain, unpredictable conditions
  - Distracting information or events
  - Problem not obvious, feedback ambiguous, standards change

- **Task constellation**
  - Multi-tasking, prioritizing
  - Sequencing, timing, coordinating
  - Evolving mix of tasks
  - Little supervision; need for independent judgment

Recall what created “processing complexity” in literacy items shown earlier

Literacy tests miss these sorts of “load multipliers”

2 + 2 = 5
Recommendations on Task Complexity?

**Interim**
- Educate for gathering/using info & dealing with contingencies
- Presume need (till proved otherwise) for concrete, step-by-step instruction with repetition, follow-up, & retraining
- Don’t assume that any task is “simple” or the need to perform it obvious
- Presume that non-adherence from cognitive overload

**Longer-term (research partners welcome)**
- Job analysis of diabetes (‘critical incidents,’ etc.)
- Simple way to rate cognitive load on patients
- Simple way to predict when & where overload (errors) most likely
Training to goals & cognitive hazards in self-management of diabetes

Aim: Keep system under control
Deal with unexpected
Limit damage
Criterion: HbA1c < 7

Practice scenarios for typical hazards & points of vulnerability
• unexpected events
• problems coincide
• etc.

Bloom's taxonomy of educational objectives (cognitive domain)

Simplest tasks
1. Remember
   recognize, recall, Identify, retrieve

2. Understand
   paraphrase, summarize, compare, predict, infer,

3. Apply
   execute familiar task, apply procedure to unfamiliar task

4. Analyze
   distinguish, focus, select, integrate, coordinate

5. Evaluate
   check, monitor, detect inconsistencies, judge effectiveness

6. Create
   hypothesize, plan, invent, devise, design

Most complex tasks

“Diabetes 101”
Recall effects of exercise on sugar

Anticipate effect of various exercise on blood sugar

Coordinate meds, diet, and exercise in timely & appropriate manner

Determine when & why blood sugar tends to veer out of control

Monitor signs; assess whether need to act, impact of actions, & how effective they were

Create lifestyle and contingency plans that minimize swings in blood sugar
Thank you.

Slides available at:
http://www.udel.edu/educ/gottfredson/reprints/2009CDC_literacy.ppt

For more information:
- gottfred@udel.edu
- http://www.udel.edu/educ/gottfredson/reprints/