J. Michael Spector

Reasoning and Critical Thinking
For OLLI-2023

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• What is it to be a thinking and reasoning being?

• What other animals think and reason?

• What factors influence thinking and reasoning?

• How to improve thinking and reasoning skills?

• Why bother?
Thinking begins with experience and continues with puzzlement ...

• I heard someone say that the future will resemble the past? How could anyone know that?
• I saw a wet spot on the door where she was standing when she passed away. What would make a wet spot like that? from H. A. Nielsen’s “A Game of India.”
• So many of the cholera cases reported in London are around Broad street. Why might that be the case?
• Many criminals die while being deported from England to Australia. Why is that happening? What can be done to prevent that from happening?
What is it to be a person?

• This question has a long history ...

• Plato argued that the most real things in existence were ideas ... things that persist are more real than things that do not persist ...

• Descartes said that he was a thinking thing ... to be a person is to be a thinker ...

• Modern psychologists include more than thoughts ... bodies ... perceptions ... emotions ... hopes ... dreams ... etc.

• Hillel said “If I am not for me who will be? If I am only for myself, what am I? And if not now, then when?”

• Bouwsma argued that what you do determines the kind of person you become ... who are you becoming?
What is it to be a person?

• What do you think?

• Time to speak out ...
One day Harry finds himself giving the wrong answer in his middle school science class and wonders: where did I go wrong? This question leads Harry and his classmates to think about the nature of thinking, inquiry and knowledge. With the help of their teacher, Harry and his classmates discover rules of formal and informal logic, relational logic and hypothetical thinking as tools to help them understand themselves and their world.

Harry Stottlemeier (sounds like Aristotle):

“To me, the most interesting thing in the whole world is thinking. I know that lots of other things are also very important and wonderful, like electricity, and magnetism and gravitation. But although we understand them, they can’t understand us. So thinking must be something very special ... In school, we think about math, and we think about spelling, and we think about grammar. But who ever heard of thinking about thinking? If we think about electricity, we can understand it better, but when we think about thinking, we seem to understand ourselves better.”
'In that case we start fresh,' said Humpty Dumpty, ‘and it’s my turn to choose a subject—’ (‘He talks about it just as if it was a game!’ thought Alice.) ‘So here’s a question for you. How old did you say you were?’ [Recall Wittenstein’s language game remarks in *Philosophical Investigations.*]

Alice made a short calculation, and said ‘Seven years and six months.’

‘Wrong!’ Humpty Dumpty exclaimed triumphantly. ‘You never said a word like it!’

‘I thought you meant “How old are you?”’ Alice explained.

‘If I’d meant that, I’d have said it,’ said Humpty Dumpty.

Alice didn’t want to begin another argument, so she said nothing.

‘Seven years and six months!’ Humpty Dumpty repeated thoughtfully. ‘An uncomfortable sort of age. Now if you’d asked *my* advice, I’d have said “Leave off at seven”—but it’s too late now.’

‘I never ask advice about growing,’ Alice said indignantly.

‘Too proud?’ the other inquired.

Alice felt even more indignant at this suggestion. ‘I mean,’ she said, ‘that one can’t help growing older.’

‘*One* can’t, perhaps,’ said Humpty Dumpty, ‘but *two* can. With proper assistance, you might have left off at seven.’
Preliminary Questions:

1. What do Harry Stottlemeir and Alice in Wonderland have in common?

2. When is it best to help someone develop good critical thinking skills?

3. How might one go about helping students develop critical thinking skills?

Game of India – Developed by NetDragon
Definitions of inquiry and critical thinking:

• “Inquiry is an approach to learning that involves a process of exploring the natural or material world, and that leads to asking questions, making discoveries, and testing those discoveries in the search for new understanding.” (Exploratorium)

• “Critical thinking is that mode of thinking — about any subject, content, or problem — in which the thinker improves the quality of his or her thinking by skillfully analyzing, assessing, and reconstructing it. Critical thinking is self-directed, self-disciplined, self-monitored, and self-corrective thinking. It presupposes assent to rigorous standards of excellence and mindful command of their use. It entails effective communication and problem-solving abilities, as well as a commitment to overcome our native egocentrism and sociocentrism.” (Foundation for Critical Thinking)
Our critical thinking research team:

- Prof. Lin Lin – Previous Director of the Texas Center for Educational Technology at the University of North Texas
- Dejian Liu – CEO, NetDragon Websoft, Fuzhou, China
- Prof. Xiaoqing Gu, East China Normal University and her researchers in Educational Information Technology
- Dr. Dawit Tiruneh, Research Associate, University of Cambridge
- Dr. Kaushal Kumar Bhagat, Assistant Professor, India Institute of Technology-Kharagpur
- Prof. J. Michael Spector, Learning Technologies, University of North Texas
- Dr. Shanshan Ma – Learning Technologies doctoral graduate, University of North Texas
- And others as the project slowly moves forward
How to Promote Critical Thinking: Preliminary Strategy and Principles

  - Start with exploration
  - Find puzzling or novel or interesting phenomena
  - Support hypothesis formation
  - Support hypothesis testing and hypothesis refinement
  - Promote thinking about larger principles and policies to guide decision making

• **Initial Principles**
  - Learner Control – support control over the what, when and why
  - An Organic Approach – promote individual growth over time
  - Challenge Learners – get the learner to have serious questions
  - Provide Opportunities for Reflection – help the learner develop a sense of growth
The nature of critical thinking

“A developmental process that proceeds from experience (e.g., observation and interaction) to inquiry, investigation, examination of evidence, exploration of alternatives, argumentation, testing conclusions, rethinking assumptions, and reflecting on the entire process. “ (Ma et al, 2020)

Critical thinking elements: Abilities, dispositions, level, time, context, knowledge, criteria, and other factors like emotions, attitudes and motivation.
The five-stage model of skills acquisition (Dreyfus & Dreyfus, Mind Over Machine 1980)

<table>
<thead>
<tr>
<th>Mental Function</th>
<th>Novice</th>
<th>Competent</th>
<th>Proficient</th>
<th>Expert</th>
<th>Master</th>
</tr>
</thead>
<tbody>
<tr>
<td>Recollection</td>
<td>Non-situational</td>
<td>Situational</td>
<td>Situational</td>
<td>Situational</td>
<td>Situational</td>
</tr>
<tr>
<td>Recognition</td>
<td>Decomposed</td>
<td>Decomposed</td>
<td>Holistic</td>
<td>Holistic</td>
<td>Holistic</td>
</tr>
<tr>
<td>Decision</td>
<td>Analytical</td>
<td>Analytical</td>
<td>Analytical</td>
<td>Intuitive</td>
<td>Intuitive</td>
</tr>
<tr>
<td>Awareness</td>
<td>Monitoring</td>
<td>Monitoring</td>
<td>Monitoring</td>
<td>Monitoring</td>
<td>Absorbed</td>
</tr>
</tbody>
</table>
Framework for Critical Thinking

Four dimensions: Ability/skill (Education), disposition (psychology), level (epistemology) and time
General Framework

• Developing Inquiry and Critical Thinking Skills
  A nine-phase developmental and holistic approach
  1. Inquiry and puzzlement (observing and asking)
  2. Exploration and forming explanations
  3. Evidence and hypothesis testing
  4. Influence and causality (fact, fiction and forecast)
  5. Explanation, communication and collaboration
  6. Coherence and consistency (argumentation skills)
  7. Assumptions and biases
  8. Perspectives and alternatives
  9. Reflection and refinement (self regulation)

*The five Cs: Communication, Collaboration, Critical thinking, Creativity, Contemplation*  ... for ages ~8 .. ~13
A series of games to develop inquiry and CR skills: phases and competencies

<table>
<thead>
<tr>
<th>Development Phase</th>
<th>Example Competencies</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inquiry and puzzlement</td>
<td>Observing oddities; answering and asking questions</td>
</tr>
<tr>
<td>Exploration and hypothesis formation</td>
<td>Identifying factors; Creating an explanation</td>
</tr>
<tr>
<td>Evidence and hypothesis testing</td>
<td>Finding relevant facts; predicting an outcome</td>
</tr>
<tr>
<td>Influence and causality</td>
<td>Differentiating correlation and causality</td>
</tr>
<tr>
<td>Explanation and communication</td>
<td>Explaining reasons and causes to others</td>
</tr>
<tr>
<td>Coherence and consistency</td>
<td>Identifying inconsistencies and contradictions</td>
</tr>
<tr>
<td>Assumptions and biases</td>
<td>Recognizing unstated assumptions; identifying biases</td>
</tr>
<tr>
<td>Perspectives and alternatives</td>
<td>Considering multiple points of view</td>
</tr>
<tr>
<td>Reflection and refinement</td>
<td>Monitoring progress and adjusting to new evidence</td>
</tr>
</tbody>
</table>
### Table 1. Frequency counts for those who did not check all skills necessary for critical thinking.

<table>
<thead>
<tr>
<th>Skill</th>
<th>Frequency</th>
<th>Percent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observation</td>
<td>17</td>
<td>81</td>
</tr>
<tr>
<td>Synthesis</td>
<td>12</td>
<td>57.1</td>
</tr>
<tr>
<td>Collaboration</td>
<td>6</td>
<td>28.6</td>
</tr>
<tr>
<td>Inquiry</td>
<td>17</td>
<td>81</td>
</tr>
<tr>
<td>Judgement</td>
<td>4</td>
<td>19</td>
</tr>
<tr>
<td>Reflection</td>
<td>20</td>
<td>95</td>
</tr>
<tr>
<td>Interpretation</td>
<td>9</td>
<td>42.9</td>
</tr>
<tr>
<td>Decision making</td>
<td>14</td>
<td>66.7</td>
</tr>
<tr>
<td>Experimentation</td>
<td>14</td>
<td>66.7</td>
</tr>
<tr>
<td>Explanation</td>
<td>11</td>
<td>52.4</td>
</tr>
<tr>
<td>Problem solving</td>
<td>19</td>
<td>90.5</td>
</tr>
<tr>
<td>Hypothesis testing</td>
<td>7</td>
<td>33.3</td>
</tr>
<tr>
<td>Inference</td>
<td>13</td>
<td>61.9</td>
</tr>
<tr>
<td>Argumentation</td>
<td>10</td>
<td>47.6</td>
</tr>
<tr>
<td>Hypothesis formulation</td>
<td>7</td>
<td>33.3</td>
</tr>
<tr>
<td>Evaluation</td>
<td>12</td>
<td>57.1</td>
</tr>
<tr>
<td>Communication</td>
<td>12</td>
<td>57.1</td>
</tr>
</tbody>
</table>
Inquiry and puzzlement

• Observation skills are developed – the focus is on the ability to notice things that are unusual or puzzling e.g., among a series of rocks, point to one that is unusual and then say why (there are 3 very unusual rocks: a geode, a fossil, and a gemstone; any answer is okay and the learner is suggested to find another unusual one until all 3 are found.
Thoughts along the way

- The approach embraces a developmental perspective that proceeds from simple inquiries to looking for answers to puzzling situations to formulating and testing hypotheses, and eventually to consideration of alternative perspectives and reflecting on one’s progress. Game challenges grow with individual growth.

- The approach can grow with teachers who can add to multiple databases which are drawn from randomly to present situations, questions, and puzzles to learners.

- The approach can be personalized. Players will have unique IDs and a record kept of situations, questions and puzzles previously presented along with responses. Questions previously answered incorrectly can be asked again to determine progress. Feedback on responses can be tailored to individuals based on past performance and prior feedback.
Example of Inquisitorial Scenario - 2

• Monarch butterflies
  It is known that monarch butterflies migrate almost 5,000 kilometers every year from Canada to Mexico and southern California and then back. An adult butterfly lives for only a few months and can fly about 100 kilometers in a day.

• What question would you like to ask first?
  a) How fast can a monarch butterfly fly?
  b) What do monarch butterflies eat during the migration?
  c) Is the butterfly that left Canada the same one that arrives in Mexico or California?
  d) Why do the butterflies migrate from Canada south to Mexico or California?
  e) Do the butterflies always migrate to the same place?
  f) Do the butterflies always return to the same place?
  g) How do the butterflies know where to migrate?
  h) How do the butterflies know where to return?
Findings to date:

1. Middle school teachers have a more narrow conception of critical thinking with less emphasis on logical reasoning – Dr. Shanshan Ma

2. There is very limited opportunity to introduce substantial treatment of critical thinking in K-12 curricula.

3. Teacher preparation programs say they support critical thinking skills, as do many others, but there is little evidence of that.
Is it possible that a person knows less than that person is inclined to believe that he or she knows?

http://www.learndev.org/BOP-AECT2002.html#anchor3938368

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