Learning by constructing self-explanation diagrams

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Talk Outline
- Learning with representations
- Self-Explaining: an effective learning strategy
- Self-Explaining with presented representations
- Self-Explaining by constructing representations

5 Levels to Think about Representations
- Information level: What is being represented - “content”
- Semantic Level: Inherent properties of ERs which do not depend on the nature of the interpreter
  - e.g. Graphical constraining
- Cognitive Level: the interaction between the ER and human capacities
  - e.g. Computational offloading
- Affective Properties: Different forms of ERs evoke different emotional responses from learners
  - e.g. interesting material is selected for active processing.
- Strategic Level: Different ERS require different strategies and may also elicit different strategies

Self-Explaining: An effective strategy
- A self-explanation - “a piece of knowledge generated by the student that states something beyond what the information gives” Chi et al (1989)
- Is self-explanation more beneficial for learning from presented diagrams or text?
  - Cox (1999) proposes that diagrams providing learners with more salient and vivid feedback to compare against their explanations.
  - Wilkins (1997) argues that diagrams invoke familiar but incorrect knowledge, and so encourage students to generate incorrect self-explanations.
Method 1: Design and Materials

Blood Vessels

- The large, muscular vessels that carry blood away from the heart are called arteries.
- Blood travels through a network of smaller arteries, which in turn divide and form even smaller vessels called arterioles.
- The arterioles branch into a fan of tiny vessels called capillaries.
- De-oxygenated blood flows through capillaries that merge and form larger vessels called venules.
- Several venules in turn unite to form a vein, a large blood vessel that carries blood to the heart.

Post-test results

- Diagram students gave greater numbers of self-explanations.
- Text students spent longer studying and they spoke more (i.e., paraphrased).
- SEs positively correlated with learning for diagram students only.

Why do diagrams promote self-explaining?

- Information
  - Representations are not informationally equivalent. Pictures contain more information than the text.
- Semantic
  - E.g., “Blood from the right ventricle flows through the semilunar valve into the pulmonary artery & then the lungs.”
  - In the diagram (using red and blue for blood high in Oxygen and Carbon Dioxide), it is impossible not to see that the pulmonary artery carries deoxygenated blood.
- Cognitive
  - Self-explaining is a challenging activity that many learners do not engage in spontaneously. Diagrams free the limited resources of learners to self-explanation.
- Affective
  - Students noticeably preferred learning from the pictures.

Re-examining this explanation

- Pictures and verbal SEs were better that text and verbal SEs.
- Are the result due to diagrams or due to construction of an alternative form of representation?
  - Maximising working memory resources
  - Benefits of translation between representations
  - Computational properties of different representations
- To explore this issue we asked whether learners draw self-explanations?
Question about drawing self-explanations

- What are the benefits of drawing self-explanation diagrams?
- What does a self-explanation diagram look like and does it differ from a ‘normal’ diagram?
- What are the differences between self-explanations in diagrams and self-explanations in text?
- Does translating information between representations without self-explaining enhance learning?

Procedure

- 12 university undergraduates (20-24 yrs old) were randomly assigned to either 1) see text and draw explanations or 2) see diagrams and write self-explanations.
- Pre-tests: 10 multiple choice questions and drawing a blood path diagram.
- Participants then studied material whilst self-explaining.
- Post-test:
  - All the pre-test material
  - Six implicit questions that required integration of information
  - Six questions knowledge inference questions that required the generation of new knowledge.

Example of a) Goal and b) Elaboration

- Goal: Human life depends on the distribution of oxygen, hormones, and nutrients to the cells in all parts of the body.
- Elaboration: At the lungs, the pulmonary artery divides into two smaller arteries, one leading to each lung. Oxygenated blood then flows into venules, which merge into the pulmonary veins that lead to the left atrium of the heart. Blood from the left ventricle enters systemic circulation through the aorta.

Examples of paraphrases

Abstract

Realistic
Results

- No difference between conditions on any measure of learning

![Bar chart showing comparison between conditions on measures of learning](chart1.png)

Results: SE and Process Measures

- No difference between conditions in types of self-explanations

![Bar chart showing comparison between conditions on types of self-explanations](chart2.png)

Results: Other Process Measures

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- Paraphrasing correlated with learning outcomes: the benefits of translation?
- Text group paraphrased more information than diagrams group and spent longer learning
- Their scores at post-test significantly correlated with their pre-test but the diagrams group did not (need for expertise?)

Summary

- Drawing self-explanation diagrams is just as effective as writing or speaking self explanations.
- The processes look remarkably similar (e.g. in types of self-explanation) but drawing self-explanations takes longer (and may require more expertise).
- Translating between representations is a separate strategy (and may be equally effective).
- Further work: comparing constructing diagrams as explanations, self-explanations and co-explanations