Title

Learning from Worked-Out Examples via Self-Explanations: How it Can (not) be Fostered

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Understanding and Scaffolding Constructive Collaboration

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Collaborative situations have started to serve as promising knowledge-building environments. Cognitive science should provide theoretical bases for them, by explaining mechanisms of how collaboration leads the participants to deeper, more conceptual understanding.

Findings of empirical studies

Our previous studies (e.g. Miyake, 1986) indicate that during constructive interaction, 1) each participant's problem interpretation and solution paths are based on each individual's prior knowledge, 2) collaboration provides different perspectives, through both others' comments and self-criticisms, and 3) the monitor views the task-doing situation from a slightly abstracted plane, which contributes to the accumulation of different perspectives.

To expand these, we have recently further analyzed the collaborative process of solving a simple fraction problem (Shirouzu, et al, 2002). The task was to get two-thirds of three-fourths on a square sheet of origami. More than ninety percent of time the subjects, both solos or pairs, either folded or marked the paper to solve it but did not calculate. When asked to solve the subsequent problem with the order of fractions reversed, the solos kept the same strategy to solve.

However, more than sixty percent of the pairs shifted to the arithmetic calculation in their second trial. The shift was a gradual one, involving three re-interpretations. Figure 1 schematically shows the shift, from the left to right. The most externally oriented, two-step strategy requires first folding the paper into four. Upon doing this, one could either start making two-thirds, or re-interpret the just-completed three-fourths as already having three equal-size rectangles, which eliminates the physical necessity of second folding. Similarly, one could re-interpret the two-thirds of the designated three-fourths as two-fourths of the original square. Re-interpreting this as one-half often led our pairs to realize that the problem was soluble by calculation.

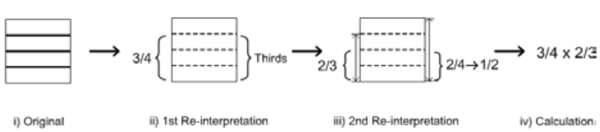

Fig. 1 Gradual re-interpretation of getting 2/3 of 3/4.

Furthermore, it was the monitor who re-interpreted, for 100% of time from level 1 to 2, and 60% from level 2 to 3.

Supporting constructive collaboration

Based on these observations, we propose that the basic components of constructive collaboration are the externalized traces of the task-doer's cognitive workings and their re-interpretations by the monitor, in verbal forms. In verbalizing the re-interpretation, the monitor reclaims the task-doing, on traces of which the previous task-doer can monitor to produce yet another level of abstracted verbalization. This iterates and produces a variety of re-interpretations, which each individual can use to restructure their own internal knowledge. The same picture should apply to inter-group collaboration, where the re-interpretation could be accumulated and become a resource for further abstraction in the entire community.

Summarizing the above, for a collaborative situation to work as a learning-enhancing environment, it is desirable that 1) it assures each individual's conceptual foundation, 2) it entertains the role exchange between task-doing and monitoring to help produce different solutions and their re-interpretations, all slightly more abstract than the previous ones, in roughly the order of their abstraction, 3) which in turn helps each participant to gain an abstract perspective. The social aspect of collaboration appears to motivate the integration of such a variety of solutions and interpretations.

Technological augmentation

Technology can augment implementation of these conditions by providing support to enhance externalization and re-interpretation. To take a simple example, the process of reading can be made visible by having subjects place cards with sentences onto a two-dimensional space. Video-recording of first stages of learning complex skills can be cut into segments and commented on to identify necessary steps. Notes can be shared, and the memos and linkages among them can be stored in the chronological order of their production, so that the production process itself can become a target for later scrutiny. We have been developing and testing such systems, and the context to use them, in a university setting to teach cognitive science to undergraduates (Miyake, et al., 2000; 2001). Use of such systems inevitably changes the way we teach and the students learn, requiring new methods to assess the effects and providing us with a new resource for further research on real-world understanding.

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