Collaborating across Multiple Linked Representation

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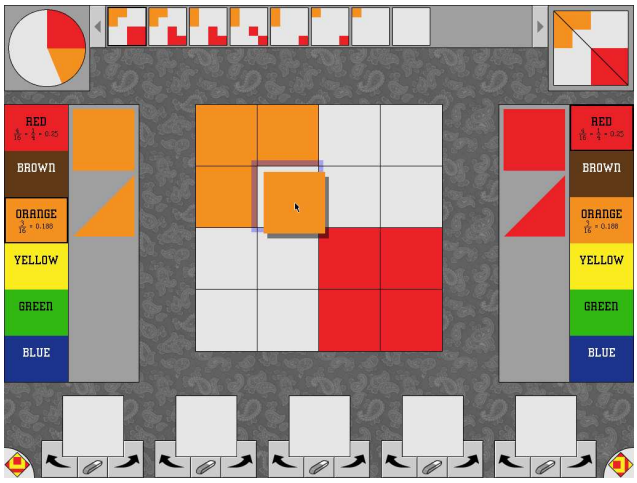

Figure 1: Working together with DigiTile

DigiTile was created for the ShareIT[1] project to investigate how shareable interfaces can support collaborative learning. DigiTile is an adaptation of DigiQuilt that runs on an interactive tabletop (Rick & Rogers, 2008). Like DigiQuilt, it is a construction kit for learning about fractions and symmetry by designing colorful mosaic tiles. Dyads stand in front of the tabletop interface (Figure 1). They move pieces from the left and right palette to the central tile as they work on various mathematical challenges (e.g., create a tile that is half red and half yellow). In comparison to a control group, DigiTile users showed significant gains in fraction understanding after a 30-minute session (Rick, Rogers, Haig, & Yuill, 2009).

One effective way to support the learning of mathematical concepts is to provide *multiple linked representations* (MLRs) (Kaput, 1989). DigiTile makes use of MLRs in a number of ways: First, the manipulable representation is the tile itself. Second, each color button represents its respective fraction in least-common-divisor form, reduced form, and decimal form (e.g., $\frac{4}{16} = \frac{1}{4} = 0.25$ for red in Figure 1). Third, the fractions are represented in pie chart form at the top left of the interface. This representation was added after the study to help learners realize that a larger denominator indicates a smaller fraction (e.g., $\frac{1}{8} < \frac{1}{4}$). Fourth, a window in the top right indicates the current lines of symmetry.

One observed benefit of working on an interactive tabletop gleaned from the DigiTile study was how aware learners were of each other's actions. One partner could add pieces to the tile while the other concentrated on a secondary representation. For example, Chris and Dave are working on a challenge to design a 4x4 tile that is $\frac{3}{8}$ orange and $\frac{3}{8}$ brown. Dave watches the button representation as Chris adds four triangular pieces (Figure 2a). Dave comments, "That's one eighth." Chris narrates, "[I'll] do it again underneath here," as he places triangular pieces in the row below it (b). Chris wants to reserve the lower rows for orange pieces and starts moving the pieces up one row. Dave agrees and they end up with the top two rows containing half triangles (c). Dave announces, "That's one fourth. It's got to be three eighths... I think the squares [meaning the central tile] need to be bigger." Dave is still concerned that they should not place pieces in the bottom two rows, so he rotates a brown piece around to fill in the gaps left by the existing triangles: "No, but we could still do this." Chris agrees. Both place brown pieces into the gaps rapidly. At one point, Dave notices that the fraction representation shows three eighths. Chris does not notice and places another piece, thereby changing it. Dave exclaims, "Three eighths. Take that [pointing to a triangle] off." He removes the piece himself and they have the brown part of the challenge (d). This example demonstrates the learning benefits of MLRs and how collaborating on an interactive tabletop supports awareness of MLRs.

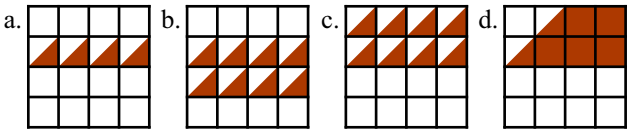

Figure 2: Chris and Dave work on $\frac{3}{8}$ brown

References

Kaput, J. (1989). Linking representations in the symbolic systems of algebra. In S. Wagner & C. Kieran (Eds.), *Research agenda for mathematics education: Research issues in the learning and teaching of algebra* (pp. 167–194). Reston, VA: National Council of Teachers of Mathematics.

Rick, J., & Rogers, Y. (2008). From DigiQuilt to DigiTile: Adapting educational technology to a multi-touch table. In *Proceedings of TABLETOP '08* (pp. 79–86). Los Alamitos, CA: IEEE.

Rick, J., Rogers, Y., Haig, C., & Yuill, N. (2009). Learning by doing with shareable interfaces. *Children, Youth & Environments*, *19*(1), 321–342.

[1] http://shareitproject.org