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Part-Whole Statistics Training: Effects on Learning and Cognitive Load

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Part-Whole Presentations and Cognitive Load

The acquisition of a problem solving procedure is a challenging task often made more difficult by examples or presentation methods that heavily tax working memory and result in the learner being unable to identify and learn the key elements of the example. In general, cognitive load refers to the amount of mental effort required to complete a task within a given time frame (Xie & Salvendy, 2000). Cognitive load theory is based on the observation that working memory capacity is limited. Because of these limitations, cognitive load theory suggests that the methods used to present information should be designed to reduce the demands on working memory (Tindall-Ford, Chandler, & Sweller, 1997) to allow for better processing of examples and ultimately more learning. One technique shown to reduce cognitive load and improve learning is a part-whole (PW) presentation method (Mayer and Chandler, 2001). Mayer and Chandler suggest that initially studying a part (piece by piece) rather than a whole presentation allows the learner to progressively build a coherent mental model of the material without experiencing cognitive overload.

Overview of Experiment

To directly test how a PW presentation would affect cognitive load ratings and skill acquisition in the statistics domain (learning to calculate t-tests and ANOVAs) 84 undergraduate students at the Georgia Institute of Technology studied and completed statistical calculation training and testing materials. The training materials were paper based and consisted of 7 different portions, which contained a brief introduction to statistical calculations and worked examples of how to calculate a t-test and a 2-group ANOVA. Those in the PW condition initially received each of the 7 portions of the training materials one at a time (part) and then were given all 7 portions at the same time (whole). This order was reversed for those in the WP condition.

The test booklet contained three test problems: 2 near transfer problems that were isomorphs to those studied during training and a third far transfer problem that required participants to conduct an ANOVA with three groups.

Participants were asked to rate their cognitive load using the NASA-TLX (NASA Human Performance Research Group, 1987) three times: at the conclusion of the first presentation method (either P or W), at the end of the second presentation method but before testing began, and after they completed the test problems.

Results and Discussion

Contrary to expectations, those who studied the training materials in a PW order performed significantly worse on the test than those who received a WP presentation order, $F(1, 83) = 1.21, p = .07; 4.34, p < .05; 4.12, p < .05$, for the t-test, 2- and 3-group ANOVA problems, respectively. The mean NASA-TLX cognitive load ratings were also found to vary as a function of presentation order with participants in the PW condition rating the part as more difficult than the whole and those in the WP condition reporting the whole more difficult than the part. This yielded a significant main effect of ratings and a significant interaction between ratings and presentation order, $p < .01$ for both. Together these data suggest the PW benefit was not obtained in this experiment but it remains unclear whether this was due to the domain or our implementation of the PW method. Perhaps a paper-based implementation in the domain of statistics is too different from Mayer and Chandler's (2001) multimedia science lesson to obtain the PW benefit. Further research is necessary to tease apart these issues.

Table 1: Variables as a Function of Presentation Order

Presentation Order	Part First			Whole First		
	M	SD	N	M	SD	N
<i>Test Performance (out of 6 possible)</i>						
- T-test	5.38	1.21	41	5.65	1.02	43
- 2-group ANOVA	4.34	1.50	41	4.92	.99	43
- 3-group ANOVA	2.94	1.94	41	3.75	1.74	43
<i>NASA-TLX Cognitive Load Ratings (100=greater load)</i>						
- Part Portion	71.68	11.05	40	64.51	15.35	43
- Whole Portion	63.15	15.09	40	72.20	13.27	43
- Test	62.27	10.65	40	58.84	15.23	43

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